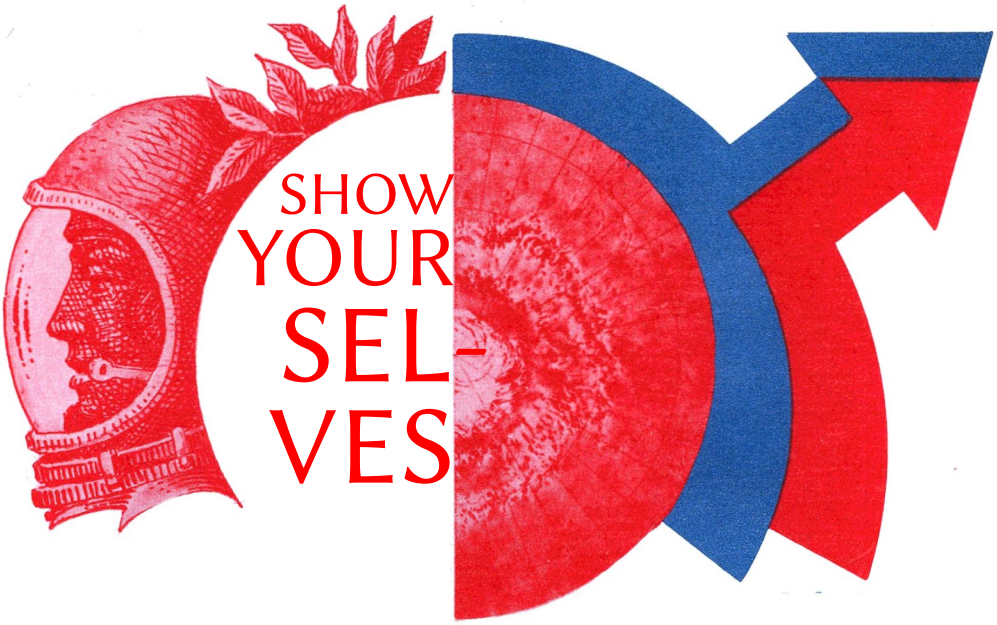
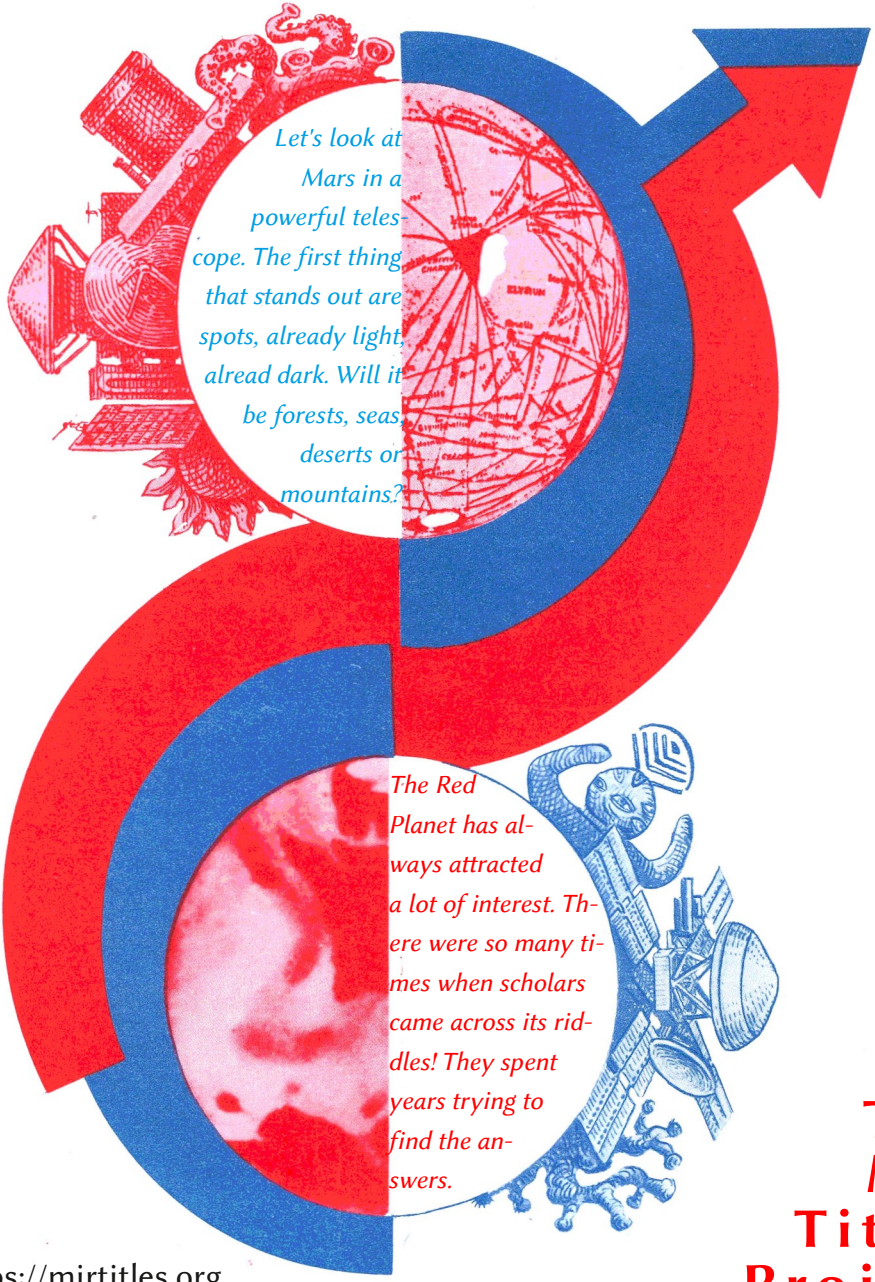


Pavel Klushantshev

The Mir Titles Project


Let's look at Mars in a powerful telescope. The first thing that stands out are spots, already light, alread dark. Will it be forests, seas, deserts or mountains?
The Red Planet has always attracted a lot of interest. There were so many times when scholars came across its riddles! They spent years trying to find the answers.

https://mirtitles.org

The Mir Titles Project

ANNOTATION

This book provides an overview of the mysteries and explorations of Mars. The Red Planet has fascinated humanity since antiquity. The invention of the telescope only deepened its enigmas, particularly with the discovery of the so-called 'canals.' This led to the idea of Martians living on the planet in science fiction. But is there really life on Mars? Do Martians exist? What are the canals? To answer questions like these space probes from the USSR and USA started the exploration of Mars in the 1960s. Going to Mars is not straightforward and reaching Mars is an engineering and technological feat. Ever since then we have continued our explorations of the Red Planet. We now have sophisticated rovers on the surface of Mars and orbiters in orbit around Mars. In the last few decades our knowledge of Mars has improved in leaps and bounds with new discoveries shedding more and more light on the mysterious planets past and future. This volume presents an outlineof these explorations, a journey that continues to advance the bounds of human knowledge with hopes that one day humans will inhabit Mars.

Show Yourselves Martians!

Pavel Klushantshev

Illustrations by V. Korolvo

Translated by Damitr Mazanav

The Mir Titles Project

Drawings by *V. Korolkov*

Translated from the Spanish and Typset in Scribus by *Damitr Mazanav*

Released on the web by The Mir Titles Project in 2025

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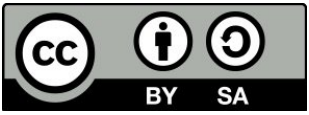

Translators Note

One of the first books that I remember reading was All About the Telescope by Pavel Klushantsev translated to Marathi. The book got me fascinated about science in general and astronomy in particular.

So, when I saw this book by Klushantsev on Mars only available in Spanish, I could not resist from translating it. Though I started the work on this some years back, it was never completed for various reasons. One of them being the complex nature of typsetting in the book. So for this book I have used Scribus for typsetting and the results have been pleasing.

Since the book was written, our knowledge about Mars has increased by leaps and bounds. I have added an additional chapter in the book that summarises the various spacecraft since the 1990s that have taken our knowledge of Mars to the next level. The Martian surface has been revelead unprecendented detail with numerous rovers and orbiters around it. The attribution of images in the last section is provided with the images.

We now have active rovers on the surface of Mars and orbiters around it sending us vital information about the Red Planet. All this with hopes that humans would one day land there. It is to those future astronauts this translation and additional sections are dedicated.

Damitr Mazanav
2025

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Damitr Mazanav

In the evenings the Sun slowly sinks towards the horizon; then we can watch it set majestically on the far side of the forest. The sky gradually darkens. Twilight falls. Somewhere in that gloomy firmament, one after another, the stars quietly begin to shine. Once darkness has completely covered everything, the sky is scattered with bright, tiny little lights.

In ancient times, people believed that the stars were the shiny heads of silver nails, firmly hammered into the celestial vault, and they thought this because the stars always held the same position in space. The same position as today, as yesterday, as years ago.

Now look closely at one of those glittering stars. All the others around it are bluish, but this particular one is reddish, like a light bulb that is only half lit.

THAT IS MARS!

THAT LITTLE STAR IS MARS!

There are several other wandering little lights just like this one in the sky.

For ages, people have been really curious about this reddish star. Its flickering reminded them of the flames from a big bonfire or a huge fire!

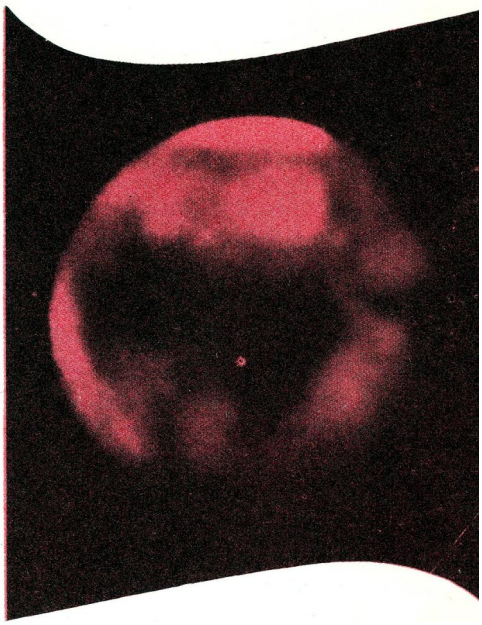
Very superstitious people used to think that the red planet was a bad omen, announcing terrible things to come. They were scared of it and named it Mars, after the Roman god of war.

When we look up at the sky through a little school telescope, everything looks bigger and nearer. If we point it at Mars, we'll notice that the stars around it haven't changed: we still see them as bright, tiny dots. But let's see what happens with Mars! It seems to move away from the stars and creep closer to us. It looks like a little round ball that isn't shooting out light rays.

If we aim the telescope at those other "wandering stars" (the planets), they will also look like small, bright globes!

Nowadays, it's actually possible to work out the distances to the stars and the planets! We've found out that we are amazingly far from the stars—we're talking about thousands of millions of kilometres away.

The planets, on the other hand,



Look at this photo from about 6 metres away. That is roughly how Mars would look, magnified one hundred times, through a telescope (when it's at its closest to Earth—we call this an 'opposition'). On that planet, you can make out light reddish areas and some greenish-brown patches. You can also spot the dazzling white polar cap.

are loads closer. For example, the trip to Mars is 'only' a few hundred million kilometres. Compared to the distant stars, Mars is practically "just around the corner," but if we compare it to distances here on our own planet, it's still awfully far.

Think about travelling all the way across the USSR (from the western borders to the eastern ones)—that's about ten thousand kilometres. The Moon is forty times further than that: four hundred thousand kilometres! But Mars? That's hundreds of millions of kilometres away!

Even though that distance is absolutely massive, we can still peer through a telescope from Earth and see Mars looking like a decent-sized ball. So, what on earth is its true size?

According to all the calculations, Mars is very big! However, it is only half the size of our Earth.

If you stood on a planet that size, it would feel as though you were on a flat field. All around you, the distance would stretch

away until it was lost over the horizon.

Let’s look at Mars through a super-powerful observatory telescope. You can see certain dark and light patches on the planet. Are they seas, deserts, forests, or mountains?

Could Mars be a brand-new world that is waiting for us?

Humans have been fascinated by the Red Planet for a very long time. Astronomers have spent hundreds of years studying it. Over all that time, it has puzzled them so many times with its mysteries! The scientists have been astonished by its secrets on countless occasions! Mars has given them many massive headaches.

Sometimes the scientists would find an answer and be delighted; other times they were wrong and, of course, felt a bit down. But they kept on watching the mysterious planet through their telescopes. They kept running into new problems, they'd scratch their heads all over again, until they found the right solution.

Step by step, without getting discouraged, they bravely kept going after their goal. They wanted to figure out, understand, and picture in great detail that distant, surprising, and tempting world.

Science is the exciting search for knowledge, the exploration of things we don't know, and the revealing of Nature's most personal secrets. Because of this, those who studied Mars had lots of disappointments and joys until they reached what we know about it today.

By the time you finish reading this book, you will have in your

hands a summary of all the information about Mars and how we managed to get it!

To start, let's remind ourselves how the Universe is put together.

Stars glide solemnly through the huge, vast spaces. They are separated from each other by absolutely enormous distances. Every star is a glowing, burning ball. One of those is our very own Sun!

Around the Sun, the planets sweep grandly along invisible, round pathways called *orbits*.

The planets are similar to each other in some ways, but different in others. They are all shaped like balls (spherical), and they all get heated by the Sun's rays. They can only be seen because the Sun lights them up. If the Sun went out, everything would be plunged into darkness!

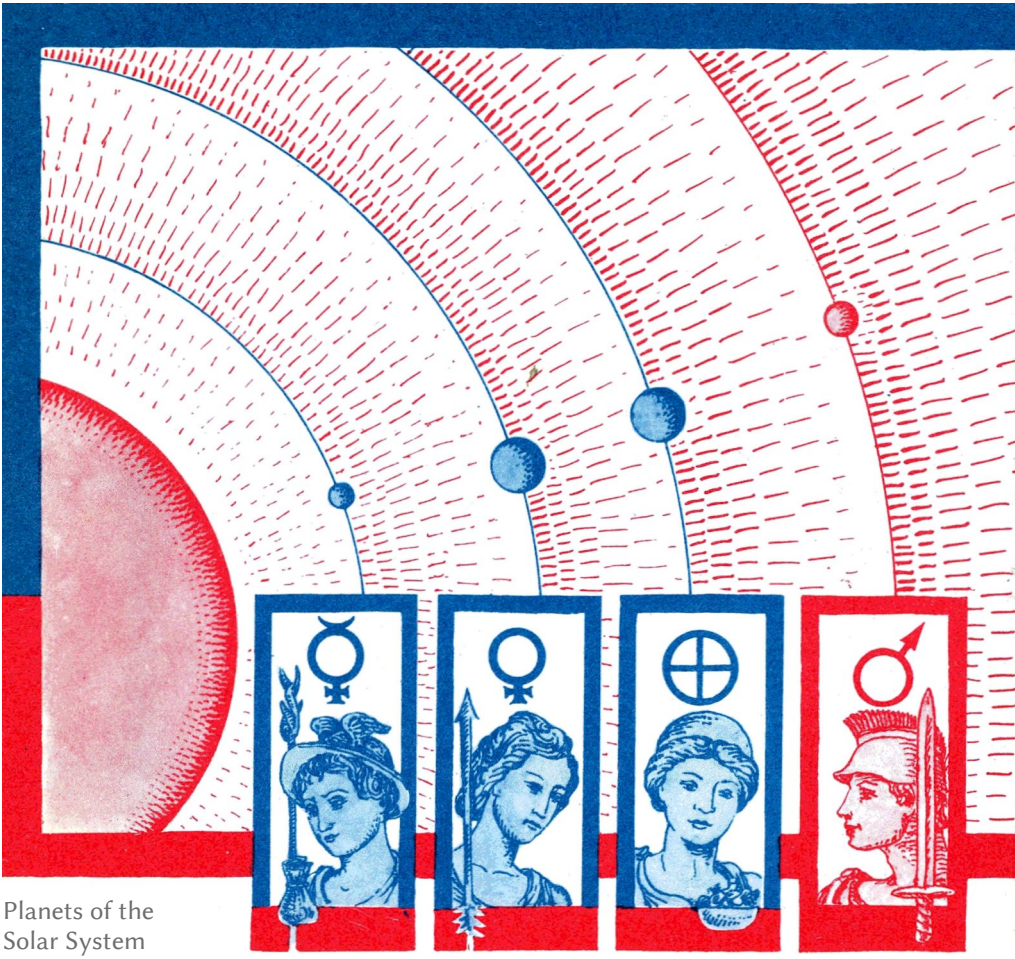
Luckily, the Sun won't suddenly go out! It will still warm us up and light our way for billions of years to come.

The Sun's rays don't heat up all the planets equally, because they orbit at different distances from it.

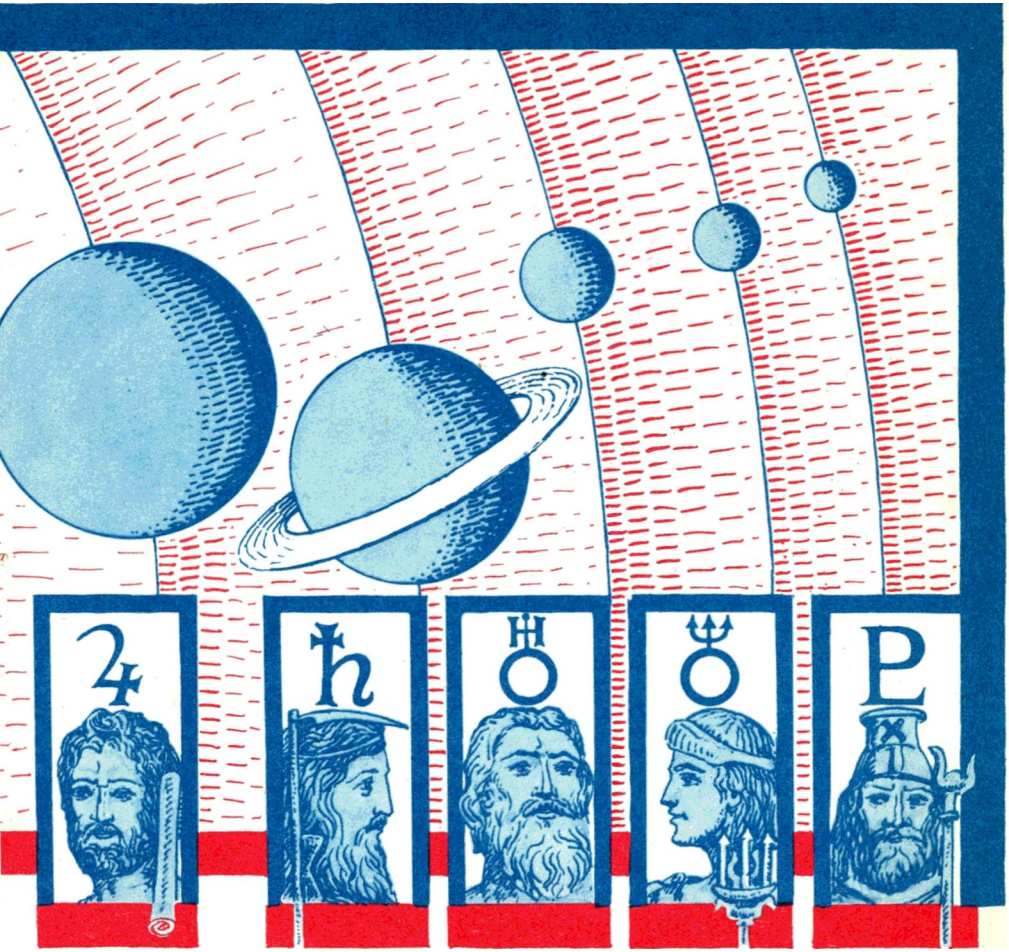
The planets closest to the Sun get as hot as fire! Those that are much further away barely get warm at all.

Mercury is the smallest planet, and it travels on an orbit closest to the Sun. Its journey is short, and it circles the Sun in just three months.

The planet Venus moves in the next orbit out. It is the same



Planets of the
Solar System



Jupiter Saturn Uranus Neptune Pluto

size as Earth. Its trip around the Sun takes over seven months.

We live on the third planet—that's the Earth! We take twelve months to complete our full lap.

Our Moon is our constant companion. It spins around the Earth, and together they both circle the Sun.

The fourth planet is Mars. Its path is so long that it seems to drag itself along lazily: it takes almost two Earth years to get all the way around the Sun once! Mars has two companions, two very tiny "moons." Because the planet is named after the god of war, its companions were given similar names. One is called *Phobos*, which means "Fear," and the other is *Deimos*, which means "Terror."

Moving past Mars, you find Jupiter and Saturn, which are enormous planets. Even further away from the Sun are smaller ones: Uranus, Neptune, and Pluto. But we won't be talking about them in this book. So, let's go back to Mars!

Mars and Earth travel around the Sun at different speeds. Earth moves quicker than Mars does.

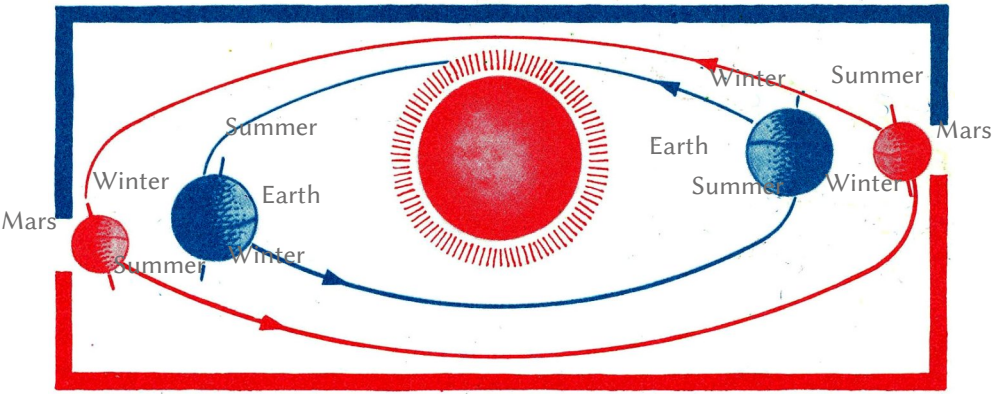
Once every two years, they both end up on the same side of the Sun, very close to each other. This event is called an *opposition*. At this closest point, they are separated by between sixty, seventy, and even a hundred million kilometres! That's a distance nearly two hundred times further away than the Moon.

A fast aeroplane, like the TU-154, would have to fly non-stop for about ten years just to cover that distance! The next "oppositions" will happen in July 1986 and September 1988. At

those times, Mars and Earth will come closer to each other than at any other time. This is called a "Great Opposition," and it only happens once every 17 years!

Even in cases like this, the distance between us and Mars is still over fifty-five million kilometres.

Mars, just like Earth, spins slowly without stopping, showing all its sides to the Sun's rays one after the other. Because of this, day follows night on Mars and night follows day—just like on our own planet. The only difference is that Mars spins a little bit slower than the Earth. Its days are half an hour longer than ours!



After the cold of winter, each day that passes becomes warmer than the last. The Sun climbs higher and higher over the horizon. Its magical rays dig deeper into the hard ground and make the Earth smile, waking up all the living things on it.

So, what is happening on faraway Mars during these moments? There, too, after the grim and freezing winter, springtime arrives!

Or is it the case that only dead stones are there, completely uncaring about everything? Do the warm rays of our little Sun just wander silently over the desolate Martian rocks, peep timidly into the deep chasms, and sadly slide across the lifeless plains, with no one taking any notice or needing them?

Is it an empty and gloomy planet that doesn't care about anything: cold or warmth, darkness or light? Is Mars empty and lonely, like the lifeless Moon?

Could it possibly be that some creature lives on that planet, a creature capable of cheering up from the Sun's warmth, enjoying its dazzling light, and waking up from a long sleep?

Let's take a detailed look at this planet through the telescope.

Hanging in the black depths of the night sky is a reddish, sandy-looking ball with a white patch on its edge. The rest of the planet is covered in dark patches. It looks a bit as if someone had smeared paint all over it.

Mars is certainly not like the Moon. The Moon really is a truly empty, stony ball. The Moon doesn't even have any air! On its surface, all the little marks can be seen with perfect clarity.

On Mars, though, the outlines of the patches look hazy, especially towards the edges. A layer of atmosphere wraps around the planet like a thin, slightly cloudy film.

Sometimes, pale, whitish smudges move across this film. They appear to be clear, moving clouds.

The Martian atmosphere is much thinner than Earth's, and its ingredients are different from ours: it hardly has any oxygen!

However, Mars does have air, even if it's not thick and is "cooked up" using a "different recipe." In this way, the planet is more like our comfortable, beloved Earth than the lonely Moon.

It would also be interesting to know if it's hot or cold on Mars. We all know that planets can have extreme conditions. On Venus, for example, it's terrifyingly hot! Its mountains are practically glowing red. If you brought a piece of paper near, it would instantly burn up, and if you threw water, it would turn into steam!

The conditions on the Moon aren't great either! During the day, the Sun heats the rocks until they're like flat irons, and at night, they freeze solid because of the intense cold.

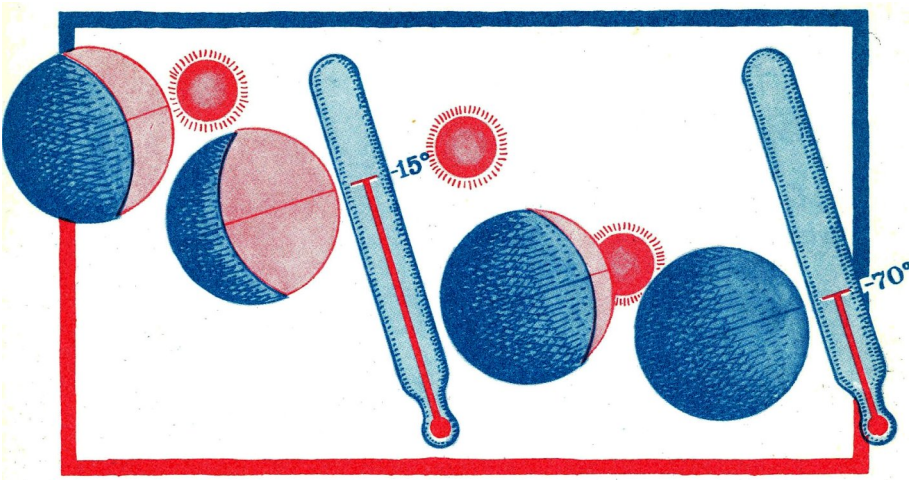
So, what about Mars?

It certainly can't be hot there! Mars is one and a half times further from the Sun than Earth is. Because of that, the Sun's rays don't warm it up as strongly.

It is colder on Mars than it is on Earth. In the planet's warmest spots, near the Martian equator, the temperature never gets above freezing. During the day, the very best you can hope for is about minus 15 degrees. That's bearable, isn't it? But when the Sun sets, the cold gets much worse, dropping to minus 70 or 80 degrees!

Why does this happen?

It's because the air is so thin! During the day, the Sun's rays warm up the planet's surface, and then at night, it cools down



very quickly.

Our thick Earth atmosphere covers us like a warm wool blanket all night long. The thin Martian atmosphere, on the other hand, would only protect us like a very flimsy sheet!

Let's carry on studying Mars.

This time, let's hunt for water on it.

Are the dark patches we see on Mars actually seas? Remember that when we look down at the ground from an aeroplane, all the bodies of water look like dark spots to us.

That's true, but when those water patches are lit up by the Sun's rays, they usually shine. They glitter like polished metal, just like mirrors scattered over the ground.

Mars spins slowly on its own axis. Its dark patches pass one by one under the Sun's rays. However, for decades, none of these patches have ever shone! On Mars, both the dark and the light patches look equally dull.

This means there are no seas, lakes, or rivers like the ones we have on Earth. Scientists, however, still call the dark patches on Mars "seas" and the light ones "continents." Why? Because from a long way away, the dark patches on any planet look like areas covered by water, and the light ones look like dry land. At first, the scientists were wrong when they claimed the dark patches on Mars were real seas. After that, they just didn't want to change the name ("seas") because they had got used to it!

But we haven't found any liquid water on Mars. Is it possible there is frozen water? What exactly is that white patch we can clearly see at the planet's poles?

They call it the polar cap, and it looks a lot like snow.

Let's watch this cap for a week or even a month. To begin with, it doesn't seem to change at all. But when spring arrives in the Martian hemisphere we are looking at, the daylight hours start getting longer.

The Sun climbs higher in the sky. It warms the ground for longer and with more strength. And guess what? The cap starts to melt! It gets smaller and smaller, retreating back towards the pole by tens of kilometres every day.

If it were regular snow, it would melt more slowly. This means the Martian "snow" is only spread across the edges of the cap in a very thin layer. You wouldn't be able to sink into this kind of "snow" or even ski on it—your skis would just scrape against the rocks!

It seems the white polar caps on Mars might not even be

proper snow, but something more like frost! Whether it's frozen water or something else, the telescope doesn't show us clearly.

Meanwhile, the first polar cap has shrunk and dried up, leaving behind just a tiny white patch. While it is the middle of summer in that half of Mars, it is winter in the other half, and the white patch on the opposite pole of the planet is growing!

The white cap on Mars grows, taking turns—first at one pole, then at the other.

So, we've confirmed that Mars has air, though it's thin and made of different stuff than ours. It is much colder there than on Earth. We don't see liquid water, but there are bits of something white that can melt just like snow or frost.

The climate on Mars is dry, bare, and harsh. Of course, to us, Mars isn't as welcoming as Earth.

But if we compare Mars with all the other planets, it starts to look like a real "holiday resort"—the best place after Earth!

When they discovered this, scientists started wondering: *Is there life on Mars?* Could there be an "Earth twin" with plants and animals, living in space right near us? Are there even clever beings like us living there?

For those who were thinking like this at the time, there was absolutely no way to check if any of it was true.

THE MYSTERIES OF MARS

We already know what the Martian "seas" are like. They are just as dry as the "continents"!

Scientists watched these "seas" for decades. They noticed that as time went by, some of them got a bit bigger, while others shrank. Once, a brand-new, enormous "sea" appeared! It grew to the size of Ukraine and covered part of the neighbouring "continent."

The "continents," because of their colour, look most like sandy or rocky deserts. But no one really knows what those "seas" actually are.

Astronomers looked through their telescopes, thought hard, swapped ideas, and argued, but they couldn't agree on what they were seeing!

They could be dark clouds, like black smoke. In that case, they would move quickly like real clouds. They would constantly and visibly change their shape, spreading out as they go.

Maybe the rocks there are simply darker. Or are they mountain ranges full of black canyons and ravines? But if that were the case, their appearance wouldn't change; they would always look the same.

One American scientist suggested: "On Mars, volcanoes erupt, spitting out dark clouds of ash, which then settles on the surface in dark layers."

If that were true, the Martian winds would have covered those ash layers with dust they carry from the desert areas a long

time ago, and these dark patches would have blended in with the light ones.

To try and solve the mystery, scientists watched the Martian "seas" carefully to see if they changed with the seasons.

They noticed that in winter, when the white polar cap was large, the "seas" were hardly visible. They looked pale and colourless, almost as if they had faded away.

As the planet moved along its path around the Sun, its winter half started to warm up, and the polar cap shrank. The astronomers watching this, of course, saw a picture of Earth's springtime happening on Mars! They imagined how, millions of kilometres away from us, little streams started to whisper, formed as the ice melted and flowed past the stones, and how the dry, thirsty Martian ground soaked up the life-giving wetness.

What happens on Earth at that time of year?

Plants wake up and eagerly soak up water through their roots. Buds start to grow. Seeds swell up, and everything turns green at the same speed. Fresh grass appears; trees cover themselves in leaves. The planet, grey after winter, warms up and spreads out its wonderful emerald carpet!

Sometimes, scientists noticed that the dull "seas" became darker as the snowy polar cap melted, as if they were being filled with sap. Other times, some of them believed the "seas" were taking on a green tint and thought that the Martian "seas" must be covered in plants! After all, lifeless stones cannot burst into bloom in spring. Cold ash can't turn green either, and grey clouds can't turn fresh. In springtime, only

living things can flourish when they are warmed by the Sun's rays.Here is the translation into playful, simple British English:

If what the scientists saw really were Martian plants, they should wilt and even lose their leaves by the end of summer.

And indeed, just as the researchers observed, in autumn the "seas" grew paler, became colourless, and looked "faded out."

One might think the idea of plants on Mars was being proven correct!

But a strange event completely baffled the scientists. On Mars, spring seemed to take a "different route" from the one they knew.

Let's remember the order in which plant life returns on Earth in the spring. The first places to turn green are the fields in the South. From there, the wave of green moves northwards, and the trees put on their summer outfits.

This all makes perfect sense! Our plants wake up with the warmth, and spring warmth travels from the south up to the north.

On Mars, the wave of springtime warmth travels in the same direction as on Earth: from the equator towards the poles, from the hottest areas to the coldest ones. The only problem is that the "plant life" on Mars takes the opposite direction!

First, the "seas" that are near the melting ice cap get darker. Then, the darkness moves towards the equator, heading to meet the warmth!

This would be like the fields in the north of Earth turning green first, and then the ones in the south!

But that's impossible! It's absurd!

Yet, everything they had observed on Mars seemed to be exactly that—an *absurdity*!

It turned out that the Martian plants weren't waking up in the spring because they were being warmed by the life-giving Sun's rays, but because they were being revived by something that came from the pole!

What could that "something" be, without which the plants couldn't bloom?

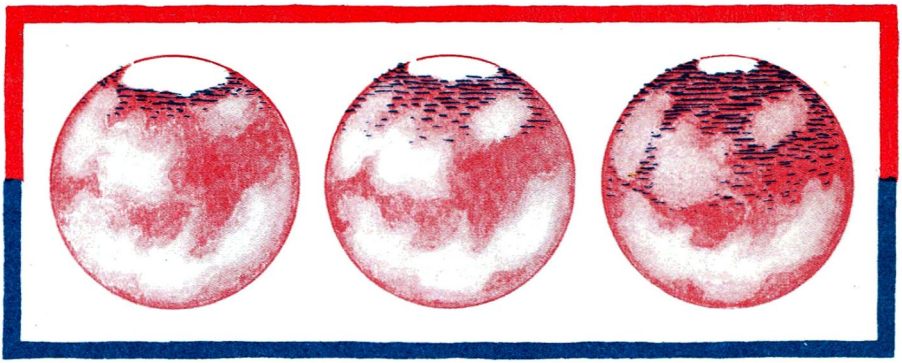
It couldn't be anything else but *water*!

For the scientists who believed in the existence of Martian plant life, there was no other way to explain it. Everything they had guessed seemed to be true. They insisted that on Mars, all the water gathered in the polar caps during winter, and the rest of the planet was dry, without water.

In spring, no matter how much the Sun warmed things up, it couldn't wake up the plants. Their slumber only ended once they got that much-needed moisture. The plants woke up, came back to life, and turned green!

Earth plants use the moisture right where they are. But the Martian ones, they use water that is "brought from far away."

The way the scientists back then saw it, everything was very neat and seemed truthful.



However, they had gotten carried away! They saw some fuzzy patches through the telescope, and their imagination painted pictures of thick, green forests. It's true that not everyone agreed that the "seas" were turning greenish and that there was a "wave of darkening," but despite this, when people talked about Mars, they kept hearing phrases like: "the greening of the seas," "the springtime awakening of Martian nature," and things like that. It was the same old story: they wished for something to be real, so they started treating it as if it were!

Humans tend to try and prove their dreams are real. From all the facts they have, they only pick the ones that suit them best. They explain anything confusing to match their existing ideas and ignore anything that doesn't fit their plan.

This is exactly what happened with Mars. An appealing and believable theory about Martian "vegetation" took shape among the scientists, but it was based on facts that could be argued against, guesswork, and unclear information. That's not even mentioning the wild ideas from people who had nothing to do with science!

These dreamers were completely thrilled about living things on

Mars that no one had actually seen yet! The most enthusiastic ones talked about that "living something" that made up the wide areas of Martian "greenery," or so they thought.

"That thing" sleeps right through the long Martian winter, they would say, waiting patiently for the spring to arrive. "That thing" is used to surviving the terrible frosts and, like all living things, it searches for the Sun. However, it manages with the little bit of warmth that the small, mild star sends it. The Sun seems small and mild to Mars because the planet is so far away—much further than the Earth is.

This mysterious "living something" doesn't need much moisture, especially as there isn't much on Mars. It doesn't wait for saving rain. Where would rain come from if the sky is almost always clear?

It fights against the exhausting winds and the sand that attack it from the "desert." Sticking its springy roots into the cracks of the bare ground, it tries hard to hold on so the blasts of the strong hurricanes don't sweep it across the planet. Fighting back with all its might, it shakes off the dust and sprouts up through piles of sand.

Sometimes it wins its struggle to survive, and sometimes it loses. Clearly, in one area, "that thing" manages to take over a piece of "desert," which is when a dark patch forms on the planet's surface. In another area, it has to retreat for a time, meaning the dark patch gets paler and shrinks. But generally, it is unbreakable and tries to conquer the entire planet.

Like all living things, "that thing" is able to feed itself, grow, and reproduce...

Mars has always captivated humans with its mysteries.

People have always looked up at the black, star-filled night sky and fixed their attention on the "Red Planet," hoping to spot their "green relatives" who are so far yet so near. They watched closely and imagined that millions of living organisms were enjoying life on that distant world. It didn't matter if it was just some kind of "vegetation." Don't we, here on Earth, share its happiness when it sprouts in the spring? The far-off "plants" of Mars enjoy the same Sun as us and send us their signal: *"We exist! We are alive!"*

Across hundreds of millions of kilometres, a "radiogram" can be sent, even without a powerful transmitter! It's as if the weak, non-thinking plants joined their efforts and shouted all at once. Huge "forests" formed and turned green at the same time. And because it all happened together, we could realise they existed. We received the "radiogram" they sent us, tirelessly, every year, and have done so for millions of years.

We cracked the message and answered: *"We see you! We see you! Wait for us!"*

How wonderful!

There's no need to blame anyone for these fantastic inventions. People need to dream! We mustn't forget that dreams drive science. A scientist must dream to avoid stopping their search—otherwise, it would be difficult for them to move forward.

Clearly, the standards for scientists' dreams should be higher than those for amateurs and daydreamers! So, we have the right to ask those scientists who spoke so confidently about

the "green wave" and the "springtime flourishing of Martian life": *Did your dream have a strong enough scientific basis?*

Did they forget about the harshness of the Martian climate? Could living things actually exist there with the drought, the cold, and the thin, unbreathable air?

We know there are certain limits beyond which no living thing can survive.

So, what exactly are those limits on Mars?

Where is it possible to live there, and where is it not?

WHERE CAN YOU LIVE?

We know that Earth's plants and animals can't live "just anywhere." Certainly, any living thing, on Mars or any other planet, would choose the most suitable place to live.

To live means to feed, grow, and reproduce. For that, living organisms need elements to nourish them and build their tissues. Plus, they need water to fill all their parts with life-giving fluid. Frozen water won't do; it has to be liquid. They also need warmth and energy to do their "work." The sources of energy must be easy for them to get, such as the Sun's rays or nutritious food.

Let's look at where these conditions exist on our own planet and observe where and how life shows up, and where it is impossible.

It's obvious that it is lovely to live on the shores of the Black Sea, which are gently touched by the Sun's rays: the mountains shield us from the winds, the warm waves roll softly, the slender trees sway quietly, and bunches of sweet grapes hang from the vines. How wonderful! Anyone would love to live there.

But things aren't the same in every part of the world. Let's go to Africa, to the Sahara desert...

The bare sands stretch right to the horizon. In some places, naked stones poke out. You can't see a single cloud in the sky. It hasn't rained for several years. Everything is dried up and blazing hot. It's impossible to touch the stones or the sand. The Sun is scorching. A tiny shadow forms beside the stones, but even there, the heat is over fifty degrees!

We couldn't live in this place; the heat would be unbearable. Thirst would torture us. With so much heat, even your feet would refuse to walk and would give up. It would be impossible to cool down, rest, or quench your thirst.

But if we look around, we'll see that the desert is not empty! A speedy lizard hides among the stones. Further on, at the foot of the rocks, a snake coils up. A rodent holds its head up on a little mound, while a scorpion peeks out from the sand.

Go right up to the stones, and you will see tiny plants growing, filling up the cracks.

According to scientists, twenty-eight different types of fungi and eighty-four types of land algae live in this "desert."

In short, there is life in this hell! It seemed impossible to live here, and yet it's not.

Clearly, this "hell" doesn't meet our needs for life. But since we are living beings, we can adapt!

All the plants growing here, all the little animals running and crawling around, all the insects flying about have completely adapted and feel perfectly happy: they don't need better conditions. The Sahara Desert has become the best place on our planet for them: it is *drier than Mars*, and yet, there is life there!

Let's move on. Now let's sail to the South Pole, to the Antarctic —the coldest place.

We reach the coast. In front of us are grim, bare rocks, almost totally covered by ice and snow. Huge icebergs float in the

freezing sea. The frosty mountain peaks are hidden beneath a dark mist. A sweeping, devastating wind blows and churns up the snow.

The colour green is completely missing. Just rocks, snow, and hurricanes. Hurricanes, snow, and rocks. Nothing else!

The cold is *minus eighty-five degrees*!

People are shut inside warm little houses, sitting by the fire. And when they have to go outside, they cover their faces with scarves, walk hunched over, and cling to a rope stretched out so they don't get swept away by the wind.

But even here, in this harsh world, there are living things.

If we clear away a pile of snow, we'll uncover a tiny hidden sprout underneath, patiently waiting for the springtime sun to appear. That sun will melt its snowy roof and show it the blue sky for a few days. It doesn't dream of anything else. Those few cool summer days are enough for it—it's completely used to it!

As if the cold were perfectly normal, an albatross circles in the sky. Seagulls grab fish from the tops of the heavy sea waves. A fat seal plays about on the beach after a big meal. Serious, impressive penguins march towards the water: they are bored and have decided to take a dip.

None of these Antarctic inhabitants would ever think of moving to warmer places. They are totally convinced there is no better spot on Earth!

We should point out that the frosty conditions in the Antarctic

are almost identical to those on Mars.

It's not only near the poles that it's cold on Earth. In regions with a moderate climate, it gets cold too, and the same happens high up on the mountains, even on summer nights. But the plants and animals are used to these low temperatures; they have adapted to them.

Animals keep warm with a thick layer of fat under their skin and their dense fur coat. During the period when the cold becomes unbearable, they go off to a quiet corner and curl up to sleep until the warmth returns.

For instance, the bear sleeps in its den for the whole winter. Also, in their own way, algae, different spiders, and worms sleep, trapped in the ice of the ponds.

Lots of plants fall into a deep sleep during the frosty weather. Some even get completely frozen! All their vital fluid (sap) turns into ice. Then, in spring, these plants thaw out and come back to life, as if nothing had ever happened. There are plants that can freeze themselves for just a single night. Every morning they come back to life, and at night they might "crack" because they turn into fragile "icicles."

If we travel all over our planet, we'll find life everywhere. Even in the most unexpected places!

Let's dive into the ocean, where an endless darkness reigns. Above our heads, we have a layer of water ten kilometres thick! Ten kilometres! It presses down like a huge mountain of rock, and yet, this gloomy, silent world is packed full of fish and other residents of the ocean depths, who feel perfectly at home there.

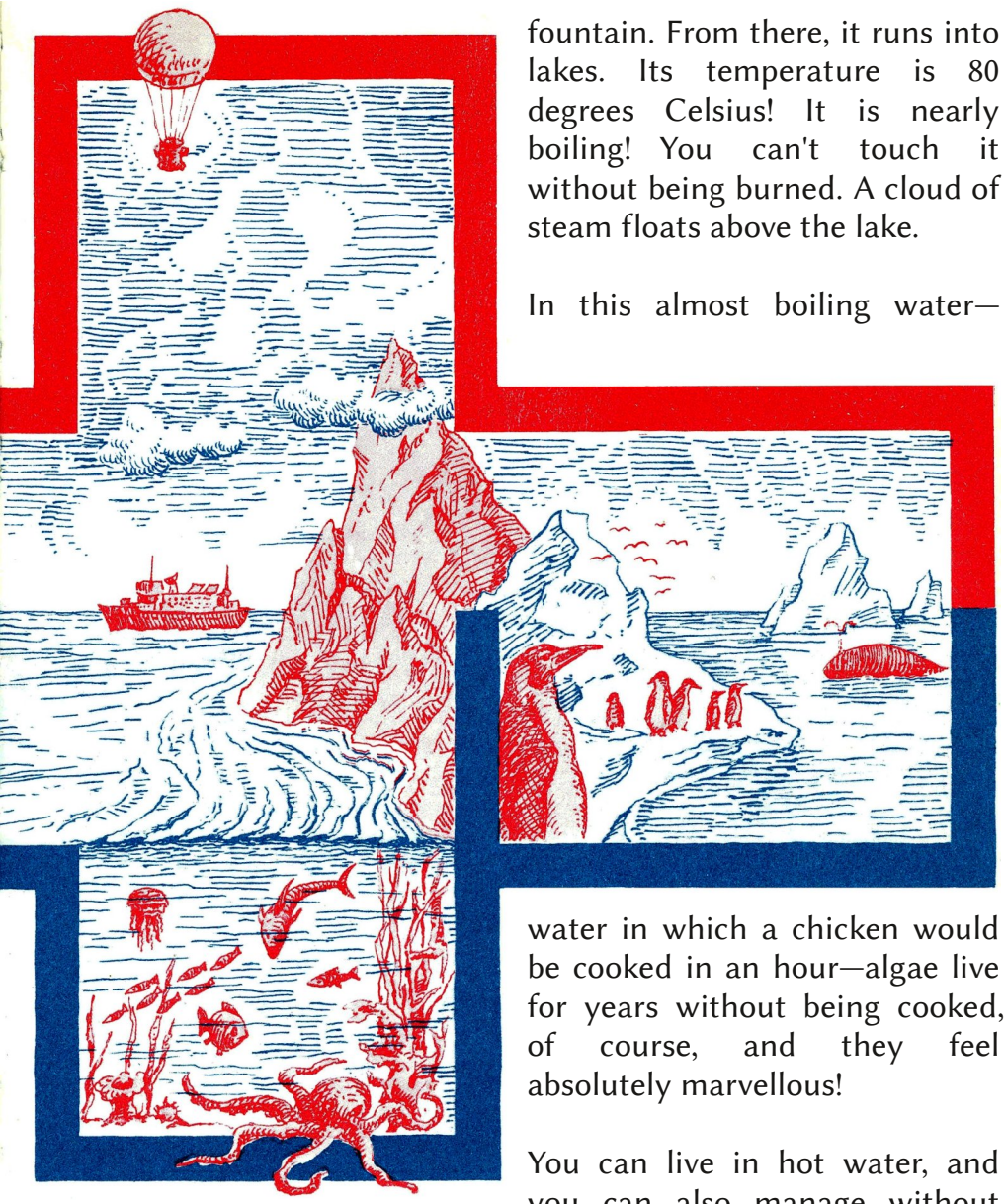
Let's climb up the high mountains. The clouds are far below. We are very near the peaks, which are covered in permanent snow. There's nowhere left to hide from the cold wind. Even so, there is still life here: the rock is covered in lichen, a grey mouse sniffs the air, and a black falcon glides across the sky.

Now let's use a hot air balloon to fly above the tops of the

highest mountains. The height we reach is over *30,000 metres*! The air is thin. It's cold. It's empty everywhere.

But even here, there is life! At this incredible height, we find dust particles that, lifted by the wind from the Earth's surface, carry bacteria "on board."

Water finds its way from deep inside the Earth up into the mountains. It rises from great depths where the stones are blazing red-hot. The boiling water bursts out into the sky as a



fountain. From there, it runs into lakes. Its temperature is 80 degrees Celsius! It is nearly boiling! You can't touch it without being burned. A cloud of steam floats above the lake.

In this almost boiling water—

water in which a chicken would be cooked in an hour—algae live for years without being cooked, of course, and they feel absolutely marvellous!

You can live in hot water, and you can also manage without water at all. You don't have to go far to see it. The larvae of the moths that eat our wool clothes

live without a single drop of water. The beetles that eat dry wood don't need it either, nor do the ones that eat flour.

Can you live without oxygen? Yes, you can! Yeasts are fungi that live without it, and some types of worms live that way too.

Beings that the human eye can't see, like bacteria, are found deep inside the Earth, in petroleum, where there is no water, air, or light. Bacteria can be found in petrol tanks, in uranium ores, in barrels of sulphuric acid, and in corrosive solutions.

Scientists have tried to work out the limits of life. They tried to find certain conditions that were unsuitable for living things to survive in.

It hasn't been easy to find them on Earth! So, that's why they decided to create these "unsuitable" conditions in the lab. Even there, it was very hard to put an end to life!

For example, they took African mosquito larvae. They dried them out so much that they looked like crunchy breadcrumbs —you could crush them into dust between your fingers! The larvae were kept in this state for several years. And when they were placed back into moisture, they came back to life!

Some of these dried larvae were placed at a temperature of *minus 270 degrees Celsius*, then heated up again, and they revived just as well as the others!

The following experiment was carried out: in large glass containers, they created an artificial atmosphere, just like the one on Mars. It had no oxygen and was very thin. They put a quantity of dry soil in the container, just like the ground on

that planet. They kept the temperature at the Martian level, with the same harsh, frosty nights.

Under these conditions, they placed some insects and various bacteria—that is, tiny living things only visible under a microscope—and watched how they behaved.

Do you think they died? Not at all! The larvae of a certain corn pest went into a numb sleep, but they didn't die. Certain worms, which scientists call "nematodes," lived as if they were right at home. And there's no need to mention the bacteria, which lived as easily as they do in Earth's conditions!

Studying living things shows us that it's almost impossible to find conditions that are completely hostile to them. It seems that living things are "never surprised by anything." When faced with a very strong frost or a complete lack of water, they respond by temporarily freezing, becoming motionless, or sleeping to survive the "difficult times." Then, when it gets warmer and there is moisture, they revive, reproduce, and carry on growing.

On Earth, perhaps fire is the only thing capable of destroying all life. Everything else is nothing to worry about. Not the cold, not the heat, not the lack of oxygen, not thin air, not eternal darkness, and not a pressure of a thousand tons!

Many of the living creatures that inhabit Earth today could move to Mars right away and live there!

Living things don't just manage to survive; they also grow and change from one generation to the next—they evolve.

Billions of years ago, only the most basic, single-celled

creatures lived on our planet: microorganisms, or simply microbes. Later, more complicated living things developed from them in sequence. First came molluscs, then crabs, fish, and lizards. And finally, the animals of our own time!

The same thing happened with plants. Now, after millions of years have passed, our planet is home to the most astonishing and unusual plants and animals due to how complicated they are.

If there really were living things on Mars, they would have no trouble existing. That's because they would be in their own environment. On the flip side, everything foreign to their planet would seem uncomfortable and unsuitable to them.

If they were to give their opinion on our Earth, they would certainly say something like this: "How can anyone live there, on Earth, where there is always unbearable heat that doesn't even stop during the night? There is so much water you could drown! The air is so thick it doesn't let you move. When you try to breathe their air, you practically burn your insides with so much oxygen, as the atmosphere has way too much of it! How can 'Earthlings' live for so long without Sun? Their sky is covered with clouds for many days! Besides, terrible torrents of that awful water are constantly falling from the sky there. They must surely wash everything they find all the way to the sea!"

Considering all this, the inhabitants of Mars would say: "No, there can't be life on Earth. The conditions there are far too difficult and harsh; it lacks suitable conditions for living!"

Let's not do the same thing as those imaginary beings from Mars! Let's say this instead: in Martian conditions, life is

seemingly possible. We don't know if it exists or not. But we also can't call those scientists “unreasonable dreamers” for believing that the Martian “seas” were the planet's plant population.

Besides, it's worth remembering that Mars kept throwing up mysteries that gave rise to even more daring guesses!

UNEXPLAINED PHENOMENA OF MARS

Why don't we do what the astronomers do? Let's go to an observatory and observe Mars. Let's try to make a discovery ourselves! And let it be something brand new!

It is night. Everything is dark. We climb up the narrow, steep ladder to the tower. In the centre of the round room, resting on a thick steel column, is a large tube, several metres long and half a metre wide. We hear the complicated mechanisms softly moving the great giant. Even though this isn't the biggest telescope, it lets us see the planets hundreds of times closer.

The dome's roof slides open, revealing the star-filled sky. Shining brightly, without a flicker, is a dazzling reddish star right in front of us.

Mars is in “opposition” now. About a hundred million kilometres separate us from it. The telescope brings it closer, to a distance of roughly three hundred thousand kilometres. For the Cosmos, this distance is tiny—less than the distance to the Moon! We can make out many interesting details on the surface of Mars that are only a few hundred kilometres in size!

Let's look at it through the machine.

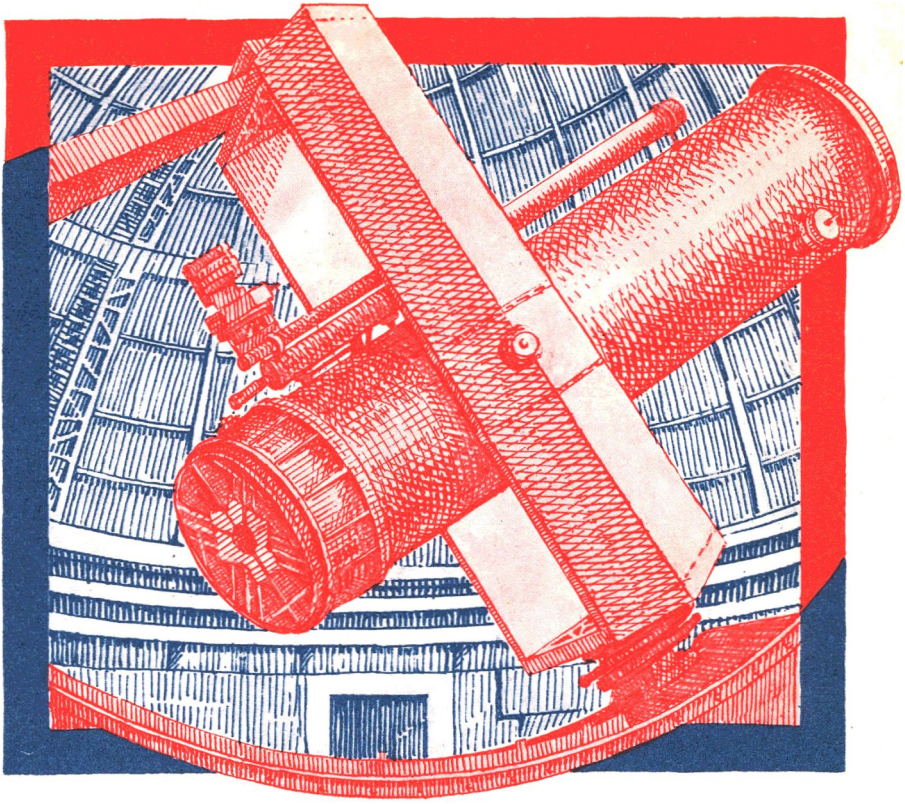
The familiar reddish disk appears in front of the telescope, with its dark “sea” patches and its white cap at the pole.

It looks several times larger than the Moon in our sky.

But what a shame that the disk is shaking and vibrating all the time! We can't manage to observe it in detail. It gives the

impression that there is a brazier of glowing coals between Mars and us and that we are looking at the planet through a jet of hot air.

Unfortunately, this can't be helped. It's the curse of astronomers. As soon as they build a more powerful telescope, the image starts to tremble like that. You can see how the hot air moves right in front of the telescope's tube.



The astronomers have done everything they can to improve the image. They build observatories up in the mountains, where the air is calmer and cleaner. They only observe on quiet nights. This helps a bit, but they still can't manage to get a

perfect image. That's because the air is never completely still.

If it were possible to build an observatory on the Moon, where there is no air at all, the situation would be different. One day, perhaps! But for now... we have to make the most of the moments when the air becomes still.

Wait a moment! The image seems to have cleared up! Look quickly!

The outlines of the “seas” look clearer. But... what is that? Some dark, barely noticeable lines have appeared on the planet!

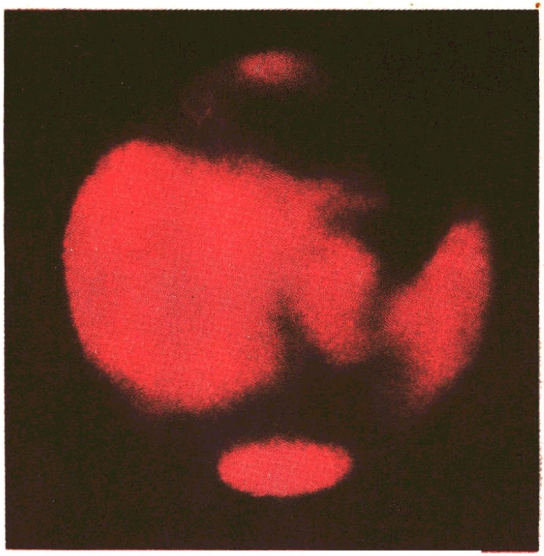
Mars now looks like a cracked clay vase that is about to shatter into pieces, or like a ball stuffed into a fine net woven from thin threads.

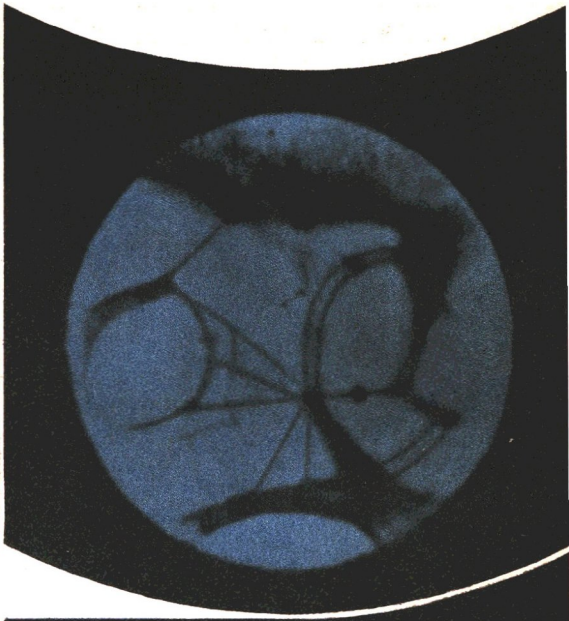
The lines are barely visible. From time to time, they break into strips or become knotty. Sometimes they look like scratches. It's very difficult to examine them. The jet of air makes it hard to see the lines and casts a shadow over the “net.”

The lines tremble, disappear, or reappear. They run across the reddish "deserts," connecting different dark patches to each other. In several places, the lines cross over, and then a dark knot is visible.

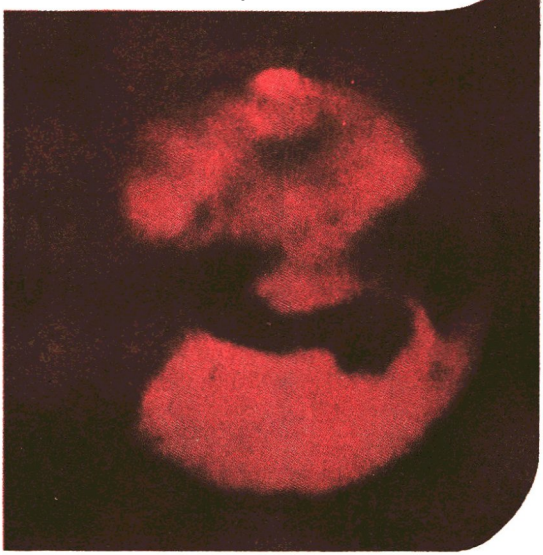
The lines are never interrupted anywhere; they are always straight. *Only straight!* Like taut threads!

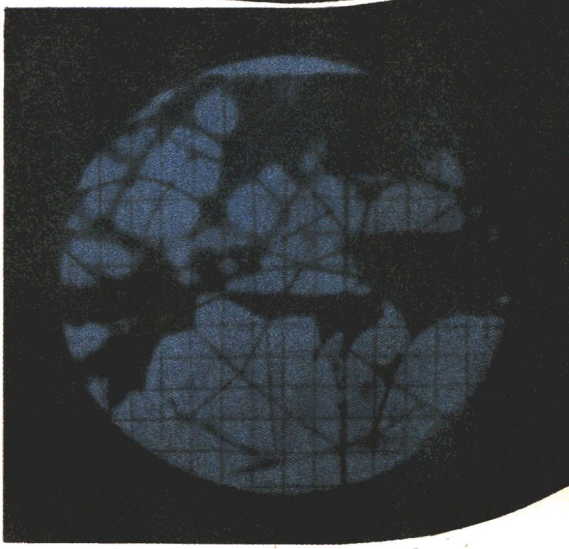
The most surprising thing is that in some parts they are double! Especially around the planet's equator. It's as if railway lines were running across the “desert.”





On the left, the planet Mars appears as it looks through a telescope when the air is hazy and wobbling: a bit blurry and faint. On the right, it appears as it looks during moments of atmospheric calm and clarity.

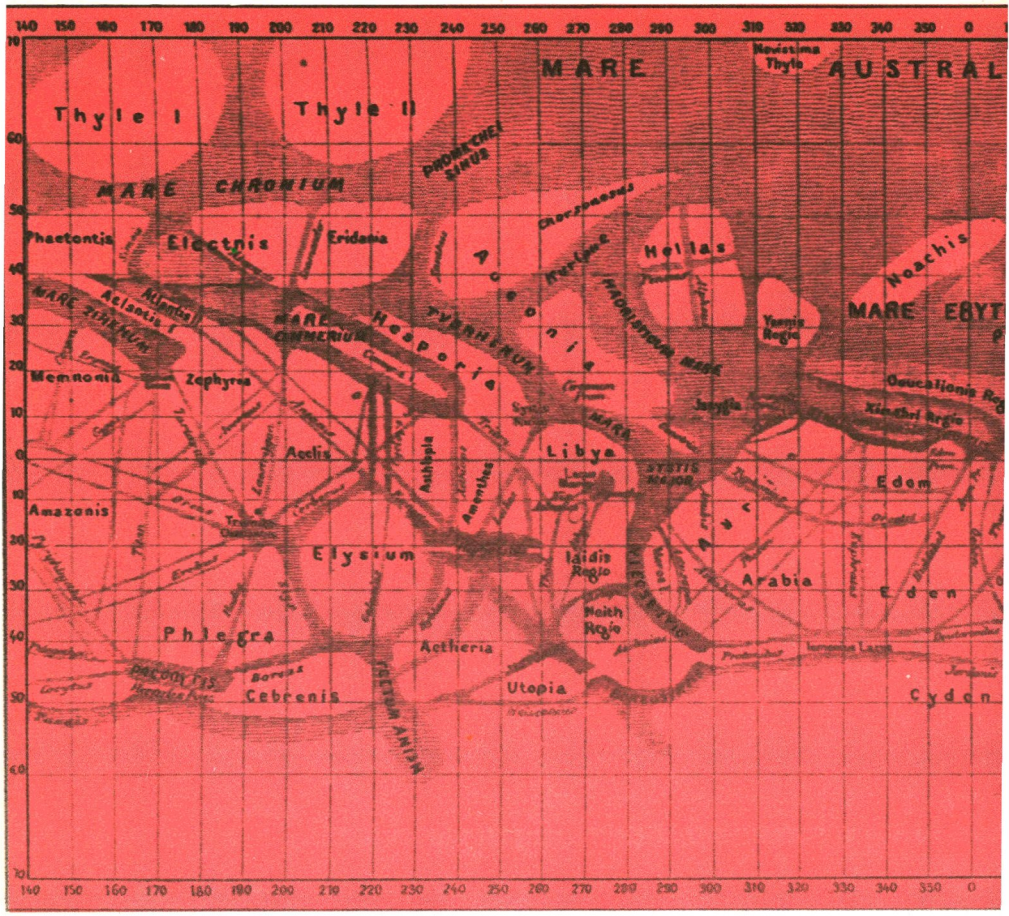




To represent some of the smaller details of the planet Mars, the artist first draws a network of lines.

The movement of the air current in front of the telescope increased again, and the mysterious "net" disappeared. In front of us, we have the usual patches of "seas." The familiar reddish "deserts."

A surprising picture appears before us! It's difficult to believe



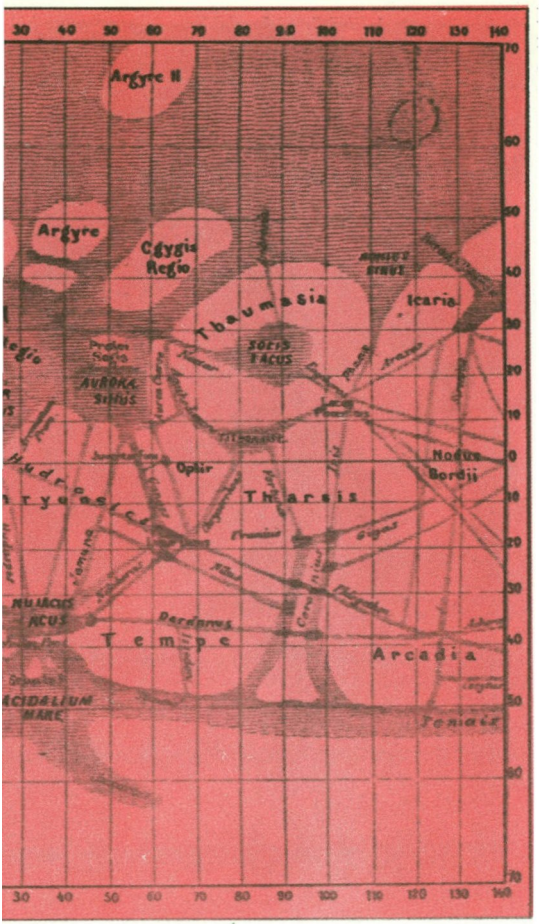
what we are seeing! A discovery? Absolutely!

But we aren't the first to achieve it. The first person to see the

mysterious straight lines on Mars was the Italian astronomer Schiaparelli, over a hundred years ago, in 1877.

He called them *"canals."*

Schiaparelli's discovery caused a huge stir all over the world. The "canals" didn't look like anything we were used to seeing on Earth or anything we expected to see on other planets. They were completely unexplained.



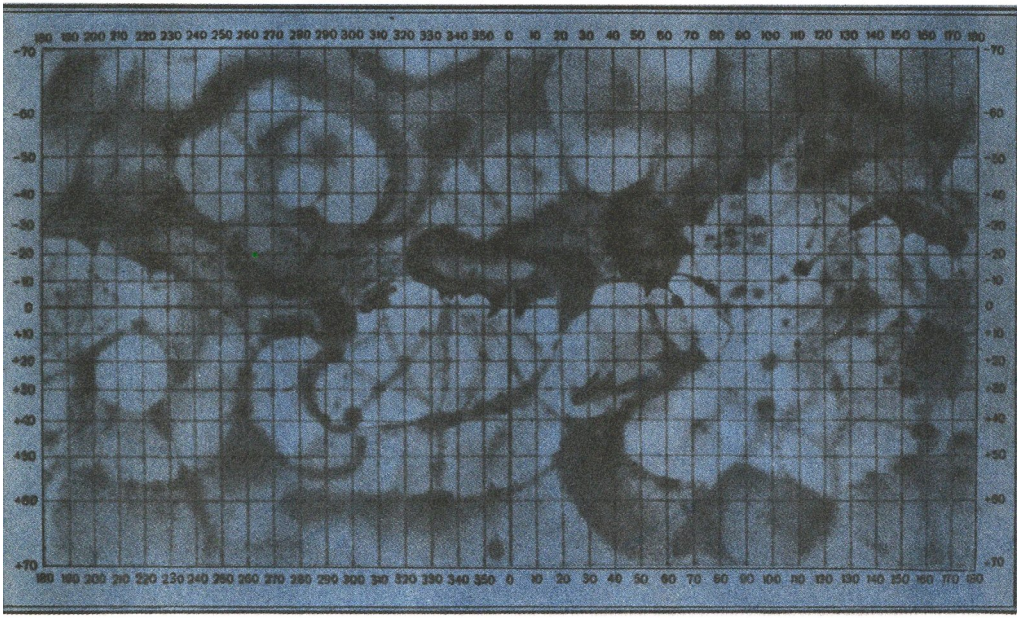
After some time, in 1909, Mars began to be studied by the French astronomer Antoniadi. He had a great destiny... a telescope thousands of times stronger! Antoniadi observed Mars and... he didn't see any "canals."

Instead, Antoniadi only made out small, separate chains of tiny spots, specks of different shapes and sizes. There were no continuous lines with smooth edges.

This was the new sensation! Mars became even more mysterious.

People started observing and photographing the mysterious

planet using the best telescopes in the world. And the strangest thing was that some people saw the “canals” and photographed them, while others neither saw them nor managed to take pictures of them.



The map by Antoniadi, based on his observations. Here, the "canals" look blurred; they have broken up into chains of intermittent spots.

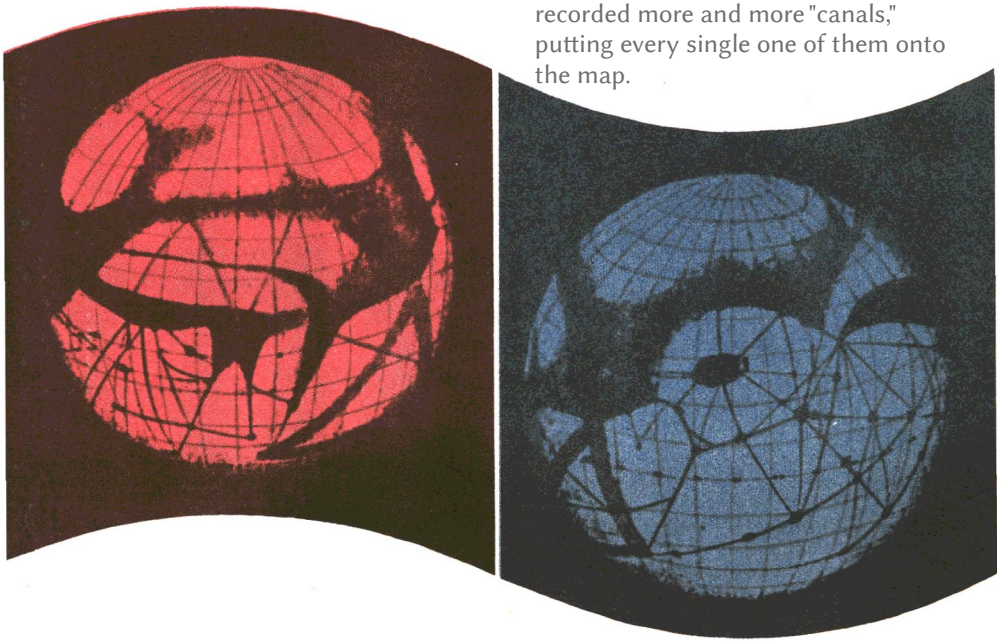
For many years, the questions went unanswered: Who was right? Do the “canals” exist or not? Were they just a product of imagination?

Apparently, that wasn't the case! The astronomers who were fans of the “canals” waited patiently for the moment when the atmosphere became calm and took thousands of photos of Mars, in which the thin, straight lines could be seen. They photographed Mars in its different positions facing the Sun, at different times of the year. Sometimes they would see one set

of “canals,” and sometimes others.

To this day, several hundreds of “canals” have been discovered. Quite a few of them stretch for thousands of kilometres. Sometimes they grow pale or dark. But they never completely disappear and never pop up in a new spot. They don't change location.

It can be stated with certainty that this is something fixed on the planet's hard surface and not something floating in the atmosphere like clouds.
And what about Antoniadi? The problem was explained in a



The American astronomer Lowell recorded more and more "canals," putting every single one of them onto the map.

simple way.

The “canals,” in reality, were not strips with smooth, straight

edges. They were more like a small chain made of water puddles, like the trail left if you carry a bucket overflowing with water and it keeps spilling. Up close, you see each puddle separately. From far away, you see one continuous strip. Antoniadi was observing "up close," since he had a more powerful telescope, and so he could see the "puddles." Meanwhile, Schiaparelli, using a weaker telescope, was observing "from afar" and saw "strips."

Even though it was clear that what was on Mars were "puddles," people kept calling them "canals." The same story as the "seas" repeated itself. Used to the old names, people didn't want to change them. In the same way, we will continue to call the little chains of dark patches "canals."

Observing the "canals," scientists noticed that they behave just like the "seas." They get pale in winter and darken in spring.

The first thing they thought of was that the "canals" were strips of "vegetation." But how could nature create sprouts that grew in such straight chains? This doesn't happen on Earth. Our forests don't grow in straight lines.

The "canals" of the "Red Planet" then became a new and obsessive mystery!

WE MUST SOLVE THE MYSTERY OF THE "CANALS"

In their effort to solve the mystery of the Martian "canals," scientists observed their own planet more closely, looking for something similar.

Perhaps, one time, from a hill in the middle of the endless steppes, you can't see a single tree nearby, and suddenly, you spot an uneven strip of thick "vegetation."

What's going on? It turns out that right there, a dip in the steppe holds moisture: beneath the green foliage, a small stream runs hidden, or there's a little marsh, or simply the ground is a bit wetter than the surrounding mounds.

We know that plants seek moisture. So, it was thought that something similar was happening on Mars. Maybe the strips of "vegetation" are moist dips in that planet's plains.

But why are these dips so straight? Earth's dips are usually winding!

The fine "net" of Martian "canals" looked like cracks, and imagination took over, picturing them as chasms, open and straight as an arrow, cutting across the Martian "deserts" and reaching the horizon.

Over time, the chasm fills up with sand and bits that fall from the edges. In place of the narrow slit, a wide, moist valley appears. These valleys get covered in "vegetation"—and those are the Martian "canals"!

Fantasy is a wonderful thing! But when it comes to science,

you have to be very careful. Let's analyse this and see if the explanation that the dark Martian strips are cracks in the planet's body is actually believable.

A planet *can* crack. Even though it's made of stone, it's not one solid piece. We can imagine it as a huge, round ball made of various blocks, formed from a thick, badly mixed mass. These blocks are pressed tightly together. Because of these stresses, in some parts of the planet's body, things happen from time to time that geologists call "tectonic faults," or, in simpler terms, the shifting of large blocks of the crust. On Earth, these are earthquakes, which cause so much harm to people.

Except that these "faults" are not straight like the Martian "canals." They are always curved and winding. You never see them from the surface; they are deep inside. The "edges" of the "faults" do not pull apart; they don't form open chasms. In a word, deep "tectonic faults," or "cracks," are possible on planets. But it's very likely they have nothing to do with the Martian "canals."

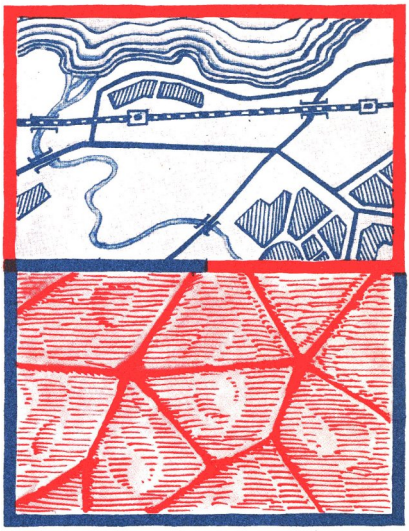
Sometimes people say: the surface of Mars could crack due to impacts from meteorites, which are sometimes very large—tens of kilometres across! Especially near Mars, there are many of them, and collisions are highly probable. And if it's hit by a huge mass, would the planet crack?

Perhaps over billions of years, meteorites, with all their "blows," have shattered poor Mars into tiny pieces? Is it barely holding together like a broken vase that would fall apart if you knocked it?

It's hard to believe this is true. Both on Earth and on the Moon, there are many places where huge meteorites have

fallen. Large hollows were created, which are meteorite craters. On Earth, there are craters of this type with a diameter of seventy kilometres. On the Moon, they are even bigger. But nowhere are there cracks around these craters.

Evidently, the planet's "thick mass" is quite gooey and doesn't crack as a result of blows. Furthermore, even if a crack did form, a highly moist valley wouldn't appear in its place. This means there wouldn't be a strip of "vegetation" either.



If a "moist valley" that was straight as an arrow, identical to a Martian "canal," and which also had Martian plants, actually existed, it still wouldn't be enough of an explanation. We must explain the "wave of darkening"! How does the moisture travel from the poles to gradually revive the plants?

We already know it has to travel thousands of kilometres! There are no rain clouds to carry the moisture through the air.

Nor are there long, powerful rivers. Some have even thought that the water runs along the dark strips through a kind of "irrigation ditch." But this couldn't be right either. Mars cannot be as smooth as a crystal ball. Its "deserts" cannot be flat, like tables. And the "canals" always look straight; nowhere do they go around any obstacle. Yet, in their path, there should be mountains and valleys, hills and lowlands.

To move without going around obstacles, the water would have to cross mountains through tunnels that are difficult to imagine.

To avoid spilling into depressions, the water would have to cross them via fantastic aqueducts supported by columns.

For the water not to be soaked up by the ground during its journey, it would be essential for it to flow along a solid bed. And to keep it from evaporating, it would have to run through pipes. Finally, it's hard to imagine the water always flowing only on slopes. That means some mechanism would be needed to constantly push it. But what? There can't be pumps or similar devices there. Where could they have come from?

The very pattern of the "canals" was inexplicable, as it is not natural for Nature to draw straight lines.

When we look down at the Earth from a plane at a great height, we see that:

the coastlines of the "seas" are winding, the mountain ranges are rugged, the rivers are meandering, the patches of forests are like messy blurs, and the lakes look like torn holes.

But, from the plane, we also see straight lines:

the roads and railway tracks, the bands of irrigation "canals," the fences surrounding factory grounds, the streets of cities, the lines of buildings...

All of this has been created by humans; their constructions can be immediately differentiated from the "constructions" of blind, wild nature. They differ, precisely, because of the

straight lines.

Here, everything becomes clear to us. In Schiaparelli's time, it could have occurred to anyone:

“The ‘canals’ were built by... Martians!”

DO MARTIANS EXIST?

Martians! Nobody knows who first came up with the idea. It is only known that about a hundred years ago, shortly after Schiaparelli, the American astronomer Percival Lowell focused his attention on Mars. He even went so far as to build a special observatory that allowed him to observe the mysterious planet for many years.

After studying the Martian "canals," Lowell announced to the world that, in his view, intelligent beings just like us lived on Mars. He said they were more developed than humans, that they had greater knowledge and inventiveness, and that they possessed a science and technology far superior to ours. The "canals" turned out to be magnificent structures built by Martian engineers.

Lowell claimed that water was scarce on Mars and only appeared a little before spring, at the poles, when the snow melted.

On this cold planet, the best place to live was in its warmer areas, closer to its equator. Therefore, the main job of its inhabitants was to bring water from the poles to the warmer zones. To this end, the Martians set up a powerful irrigation system across the entire planet.

To transport the water, they laid pipes from the poles all the way to the cities and plantations, crossing the dry "deserts."

According to him, the pipes were very thin, which is why we couldn't see them from Earth through the telescope. But, along the pipes that crossed the "desert," there stretched oases, gardens, and small settlements: this was what we saw as

"canals" or chains of dark spots. They were like the green fields around our villages that line the railway tracks somewhere in the deserts of Central Asia.

Everyone listened to what Lowell said, read his books, and it all seemed very clear. They believed his claims. Judge his statements for yourselves:

The wave of darkening moves "in the opposite direction" because this is not a natural phenomenon, but the work of intelligent beings—that is, in this case, the Martians.

The "canals" turned out to be straight because the Martian engineers laid their pipes along the shortest routes. Building tunnels and bridges presented no difficulty for them. And so the water reached the intended place more quickly.

Lowell 1855-1916

The speed at which the water flowed across the planet was uniform because it was propelled by precise machines. Everything was calculated. The water arrived at the settlements according to a schedule. Everything was functioning correctly to receive it.

Apparently, according to him, they had set up a system of large dams in the mountains from where the water would flow on its own. From the depressions, they would pump it back up to the next mountain.

Or perhaps, the water was constantly being pumped by powerful machines, just as we do when transporting oil through pipelines that run for thousands of kilometres.

Maybe everything was different. And the Martians didn't distribute the water through pipes but used "cisterns" that travelled along some kind of "railway lines." From Earth, we wouldn't be able to tell the difference. The water would arrive at a location and the plants would flourish. How the water arrived, by rails or by pipes, was unknown.

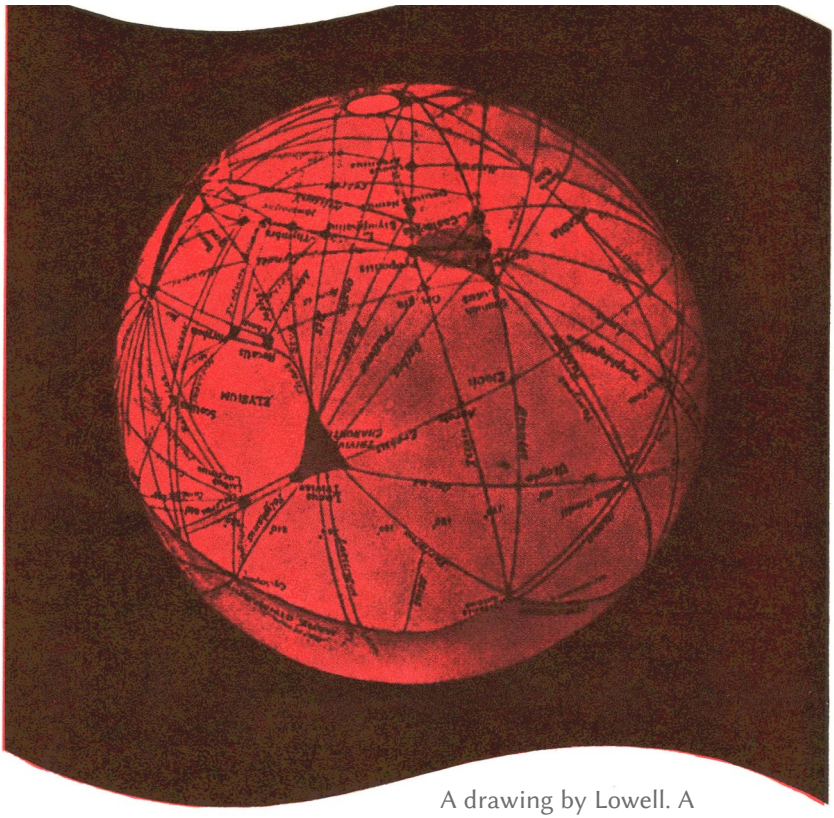
If the Martians were capable of supplying water to every corner of their dried-up planet, you can imagine how intelligent, developed, and powerful they must be! The imagination projected the most incredible and magnificent structures onto Mars. Daydreamers dreamt of vast and fascinating cities, gardens of unusual beauty, automated and extraordinary factories, and surprising means of transport.

And they dreamt of our "relatives," the hardworking owners of the planet: the Martians.

It's a lovely dream, isn't it? What a shame that all of this was

nothing more than the suppositions of the American astronomer Lowell; just another new hypothesis.

This generated differing opinions. Scientists weighed up this hypothesis rigorously, with scepticism and distrust. They explained that if beings this intelligent really did live on the neighbouring planet in the Cosmos, they would have communicated with us a long time ago. They could, for example, send signals with powerful light beams. Our radio receiving stations could pick up their "radiograms."



A drawing by Lowell. A hemisphere of Mars with "canals." Each one of them was given a name.

It would cost them nothing to send some kind of robot using artificial satellites, just to make themselves known. Finally, it wouldn't be difficult for them to land here and introduce themselves in person.

But none of this had happened; Mars was silent. That meant that such Martians did not exist, the scientists said.

However, how to explain the "canals" and the other riddles of Mars?

The scientists stated that it was not yet possible to give a definitive answer and recommended continuing the study of Mars.

The attitude of science fiction writers towards Lowell's hypothesis, and of all dreamers in general, was different. The possibility of meeting "intellectual brothers" was very appealing. While the most rigorous scientists did not accept this supposition and demanded proof, the fantasists and dreamers let themselves be carried away by his words. They asserted that life on Mars was possible, and highly developed, with diverse plant and animal kingdoms. Some animals could have evolved over time into rational beings, just as the ape transformed into man on Earth. Therefore, it was very probable that Martians existed on Mars.

The sceptical scientists replied: *"it is possible"* still does not mean that *"they exist."*

"What's the problem?" the fantasists replied. If something was possible in principle, they not only had the right but were obliged to try and picture it. To show what "that" might look like and to explain why they thought it was possible.

According to Lowell's hypothesis, the "canals" are strips of "vegetation" running alongside Martian irrigation works.

Fine, let's temporarily set aside scientific rigour and hear in more detail what the defenders of Lowell's hypothesis said back then:

If life is possible on Mars, nothing is known about the degree of development it may have reached.

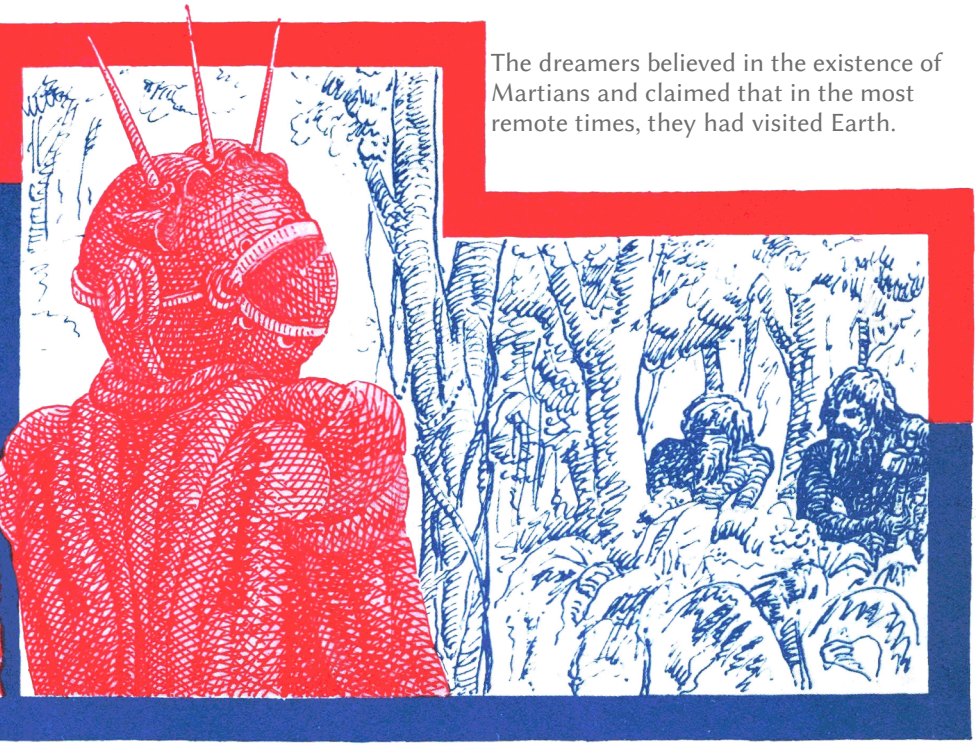
Are the Martians more primitive than us? Or are they at the same level as us? Or have they surpassed us?

Life could have appeared on different planets at different times

and developed at different speeds.

On Earth there are worms that have not changed for millions of years. Meanwhile, other living beings developed in more favourable conditions and helped to enrich the animal world.

Rational beings can also develop at different rates. Fifty thousand years ago, Humanity lived in a wild state. Man inhabited caves, hunted animals with stones or sticks. Later, they spread across the whole planet. Some went to the forests, others to the deserts, and others to the mountains. They moved to hot and cold countries. They reached dry and marshy places.



The dreamers believed in the existence of Martians and claimed that in the most remote times, they had visited Earth.

Perhaps the Martians faced many difficulties. They couldn't

dedicate themselves to science. First and foremost, they had to think about how to survive. And so, they remained in a savage state compared to us.

Or, conversely, perhaps we are "behind" them.

According to the dreamers, the Martians might be ahead of us not by one year, but by a hundred. Or even a thousand. Or, why not, by millions of years.

They could have launched spacecraft when primitive inhabitants on Earth, dressed in furs, were still warming themselves by the fire. Or even before, when wild animals dominated our planet.

It's possible that they reached us a long time ago. Perhaps they have flown here more than once. They landed and looked around, but they didn't find anyone to talk to. Maybe, at first, a clumsy brontosaurus peered from behind a bush, its tiny head attached to a ten-metre-long neck. Later, after millions of years, a frightened savage, armed with a club, watched them from behind the stones. Then the Egyptians or Indians paid them reverence, believing the Martians were all-powerful gods who came from the sky.

So, Humanity adapted to the most varied living conditions. Some invented and built various machines, others were left behind. Today, there are still secluded corners on Earth, far from civilisation, where people live who have never seen brick houses, cars, or televisions.

The life of the Martians could have unfolded along a path very different from ours.

The fantasists were asked: *Do you believe that the Martians have surpassed us? If so, why don't they visit us?*

They would answer: What interest do they have in visiting us now? It could be that they are waiting for us to go to them. And it is possible that they have been to our planet in the past. If we search carefully, we are sure to find traces of their visits.

Before, no one was interested in looking for these traces because it was assumed that it was not possible to fly from one planet to another. Only now, when crewed rockets are launched into space, when man has reached the Moon, has it been believed that this is possible.

These interesting and convincing hypotheses were put forward by the science fiction authors, followers of Lowell.

They not only considered it possible to find traces of Martians on Earth, but they also started looking for them themselves.

TRACES OF MARTIANS?

The trackers of "Martian traces" used to ask: *Do we humans truly know our own history well?*

Do books exist in which one can find an ordered account of the history of Humanity, covering all its aspects: eras, peoples, geographical zones, and the most important events?

Clearly, no such books exist.

In the beginning, knowledge was passed down orally. There was no writing. Everyone told the story in their own way, embellishing and distorting it. Then they learned to write. But they didn't know how to preserve books; they burned them in times of war, tore them up because they disagreed with what was written, or simply lost them, without ever understanding the value they represented.

Inhabitants of other worlds could have visited Earth without leaving any trace.

However, if the evidence were preserved, in what form could it have reached us?

Let's imagine, for a moment, that inhabitants of Mars came to Earth. And that they found savage tribes who had never seen a pot or a cart, much less a rocket. That is, primitive men covered in furs and armed with clubs.

It's likely they would have panicked, thinking the Martians were witches, sorcerers, or gods. They would watch them with fear and submission, hiding behind bushes.

It's known that in the 15th century, the American Indians received the Spanish, who arrived from Europe, as gods.

Once the "cosmonauts" had left, the astonished savages would tell others what they had seen. Do you think they would say: *"A rocket from Mars landed, and cosmonauts dressed in spacesuits emerged from it"?*

Of course not. They wouldn't even know those words: "rocket," "cosmonaut," "spacesuit." They would describe it with their own words: "A boat came down from the sky, and gods wrapped in skins came out of it."

Why "from the sky"? Because they had no idea what Mars was.

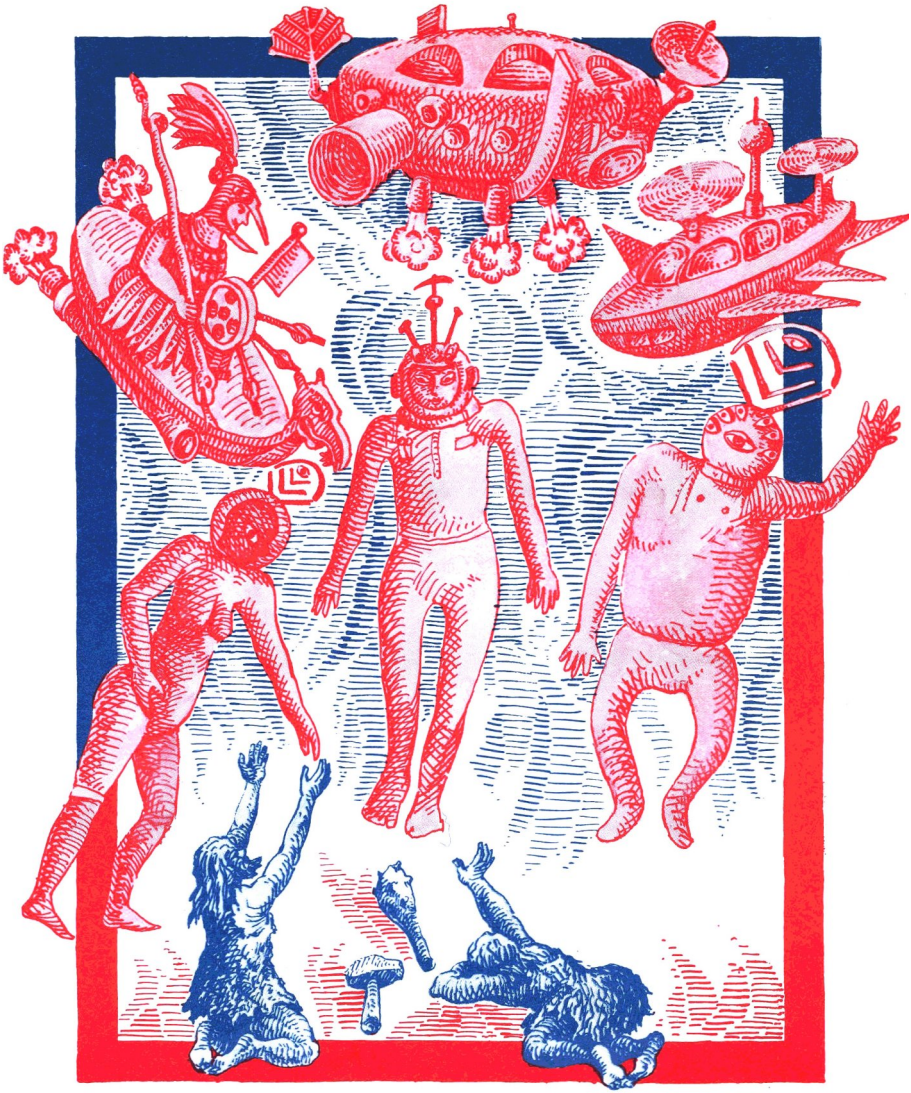
Why a "boat"? Because they didn't know any other type of transport. And they wouldn't be able to find any word other than "boat" to name the rocket.

Why "wrapped in skins"? Because they wouldn't have known about any other kind of clothing than furs. They would call any clothing a "skin."

Why "gods"? Because the "cosmonauts" surely performed many wonders before their eyes, and primitive men could only think they were almighty gods.

These people, at least, would have seen the rocket with their own eyes. But their children would only have heard the stories they learned and continued to repeat: *"A boat came down from the sky, and gods wrapped in skins emerged from it."* And later generations would imagine it exactly like that. They would think that a wooden boat slowly descended from the clouds,

from which men covered in animal skins emerged.



The dreamers believed that the "traces of Martians" should be sought in ancient legends, myths, and engravings.

Then the storytellers would start adding many details of their own. They would try to embellish the information, each to their own liking. And so, the boat would become silver with golden wings, the men would turn out to be giants, and the skins, magical clothing made of swan feathers.

That is why everything that manages to reach us is very distorted. As we can see, it shouldn't surprise us that in these narratives, Martians are called "gods.

This means that we should not look for scientific data about visitors from other worlds in the narratives, but rather stories about the *"gods who came to Earth from the sky."*

That's very interesting! Almost all peoples have stories about gods who descend to Earth and then leave again!

Isn't this story captivating? And it could be a distorted account of Martians that has been told for thousands of years! That's what the science fiction writers thought. They believed it was necessary to look for traces of Martians, first of all, in ancient writings, in legends, and in drawings from thousands of years ago.

But according to these writers, there are also tangible traces in ancient monuments.

Let's look at some of them.

Let's travel to Southwest Asia. Not far from the Mediterranean Sea, we find the Anti-Lebanon mountain range. Before us is the terrace of Baalbek. It is a massive structure, famous for its polished stones, each weighing two thousand tonnes.

A powerful locomotive weighs 250 tonnes. That means each of the stones in the Baalbek terrace alone weighs as much as eight locomotives!

These monstrous, heavy blocks of stone were hauled up from the quarry located hundreds of metres below, at the foot of the mountain, and carried all the way to the top! How was such a huge weight managed up the mountain?

History tells of many cases where men, gathered in large numbers, moved enormous rocks up mountains.

The Egyptians built their famous pyramids without any cranes, using stones that weighed up to a hundred tonnes.

In Leningrad, in Palace Square, there is the Alexander Column, made from a single piece of granite weighing six hundred tonnes. Two thousand workers moved and placed it by hand, without cranes. They did everything with the help of ropes and wooden levers.

But such examples are nowhere near two thousand tonnes! That is why the unusual idea arose that someone helped the ancients build the terrace of Baalbek. Perhaps they were helped by the Martians, with a type of machinery that we do not yet know about.

The archaeologists laugh and assure us that there were no such Martians, because the writings from those times are preserved, and there isn't a single word about it. Did slaves carry the rocks on their shoulders? Nobody knows how they managed to lift that inconceivable weight.

We head to India. In the city of Delhi, near the ancient Qutub

Minar tower, there is a large iron pillar. It is eight metres high; its circumference can be spanned with one's arms. Its weight is twelve tonnes.

The pillar is made from a single, solid piece of iron. This iron is of such a high quality that it has been standing there in the open air for fifteen hundred years and has not rusted. Common iron, in the same amount of time, would have been reduced to pure rust.

How did the ancients manage to make that pillar without blast furnaces or metallurgical engineers?

Would they have melted down an iron meteorite that fell from the sky? Meteorites are sometimes made of very pure iron. However, melting down such a giant, without mixing it, would be incredibly difficult even today. How and who could have solved this problem?

It occurred to some dreamers: could it not have been strangers who arrived from the sky, who visited our ancestors to leave us proof of their visit and to give us a puzzle?

As time passes, everything will be explained in a simpler way.

Let's move to the Sahara Desert to see the marvellous rocks of Sefar.

In them, we observe carved drawings. They were made by our ancestors approximately eight thousand years ago. The drawings were analyzed by the French scholar Henri Lhote, and they depict human figures, dressed in incredible outfits, and animals. On their heads, they wear helmets, similar to gourds, with openings for the eyes. The clothing reaches down

to their heels. Strange details protrude above the heads of some figures.

In ancient times, men liked to wear strange garments to appear more terrifying. While hunting, it was necessary to scare the wild beasts; in war, to scare the enemies.

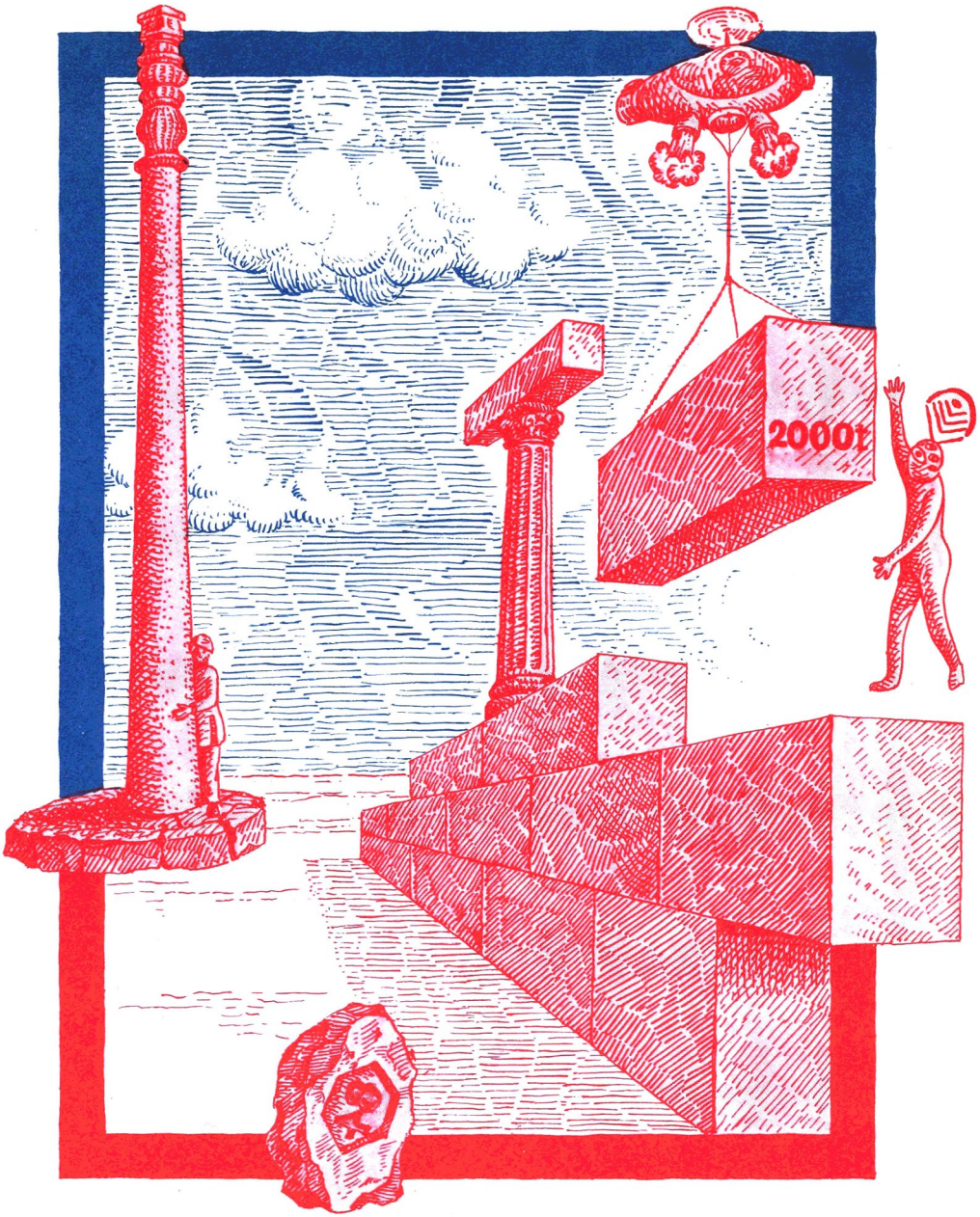
But why did they cover their heads with a type of helmet that strongly resembles the ones our cosmonauts use?

The science fiction author A. Kazántsev once said humorously: "What if our ancestors had seen Martians on Earth?" It is possible that the strangers looked like humans, but they couldn't tolerate our air, so they wore spacesuits that made them look like cosmonauts: the head encased in a globe and the body in a thick garment.

With their might, the Martians must surely have awakened envy in our ancestors. Humans would have liked to be like them. It is likely that after their departure, the Earthlings imitated the clothes of those guests from the sky, and played at being Martians, just as children play at being pilots, sailors, or hunters. Millennia passed since humans saw those "cosmonauts" with their own eyes. There were no photographs. Nor were there exact drawings or descriptions. There are only some cave paintings made by people who didn't draw any better than a five-year-old child.

Furthermore, these naive drawings were repeated many times over time, and of course, they became distorted.

That is why—according to A. Kazántsev—when you look at the cave paintings in the Sahara Desert, you can give them any interpretation:



The Delhi Iron Pillar and the Terrace of Baalbek

that we are looking at war clothing;
that it is an unusual sorcerer's attire;
it is a suit that serves as a shield for the hunter, etc.

But it could, in reality, be an imitation of those almighty strangers whom our most remote ancestors had seen. For now, these are enigmas of history.

The dreamers have found many "enigmas" of this kind. But they cannot be considered authentic traces of the Martians. Although they still offer some interest.

In recent times, much has been said about the Tunguska meteorite.

On June 30, 1908, an object as blinding as the Sun streaked across the sky of the impenetrable Siberian taiga. It could be seen for hundreds of kilometres, and its clamorous thunder could be heard for thousands of kilometres. Seismographs (devices that record earthquakes) all over the globe detected the shock. The following night, a kind of dust floated in the sky all over the Earth.

After many years, the place where the object was supposedly hit was located. However, despite intense searching, no crater or meteorite was found. But, for tens of kilometres around, the forest was all scorched and knocked down.

It was believed that a huge meteorite had exploded in the air, several kilometres high, completely disintegrating. Although they did not find the pieces either.

The mysterious is a treasure for the science fiction writer, who can allow themselves to make any assumption. And, indeed,

our aforementioned writer A. Kazántsev did not overlook this event.

“Something” exploded over the taiga? I know what it is! A Martian spaceship descended to Earth and suffered an accident! Its atomic fuel exploded!

There was a great uproar. Kazántsev's fantasy appealed to many and seemed to approach the truth. Over time, the mystery of that catastrophe began to clear up.

In recent years, scientists have examined all the traces of that enigmatic explosion. Currently, almost everyone agrees that, in the year 1908, Earth collided with a comet.

The head of the comet was made of stones bound together by ice, and the tail, of dust. The head entered the Earth's atmosphere at a high speed, ignited, and exploded. Its content completely disintegrated. The tail dispersed into the atmosphere and produced that haze, which floated around the world for a few days. *It certainly wasn't any Martian spaceship.*

In the search for traces of Martians on Earth, one should take precautions so as not to become ridiculous.

Once, the editorial office of the newspaper Komsomolskaya Pravda received a letter. A geologist reported that while drilling a well on the banks of the Pechora River, at a depth of 760 metres, he found a stone with inscriptions and a strange drawing stamped on it. Certain hieroglyphics—complicated symbols—could be seen, easily attributable to the hand of rational beings. The truth was that this stone was on the Earth's surface 200 million years ago. At that time, there was no sign of human existence.

One might think that these inscriptions were made by strangers who came from other planets, right?

They began to study this stone, and it turned out... that the head of a screw had been carved into the stone. Apparently, it had broken off the drill used to bore the ground and fallen into the well. Pressed against the stone, it left an impression on it. Then, they lifted this stone to the surface. The mysterious hieroglyphics were only the number 84 stamped on the screw, which appeared inverted on the stone.

As you can see, in this whole story of "traces," there are many debatable and erroneous aspects.

Nowadays, humans have already reached the Moon; flights by cosmonauts to Mars and other planets in the solar system are technically possible. In theory, interstellar flights are also possible. This means that visits to Earth from other planets in the solar system, as well as from planets in other systems, are also possible.

For these reasons, it is feasible that "traces of strangers from other planets" will be discovered on Earth. But we must be very careful in our search and, above all, know the history of peoples, of science, and of technology well, so as to rule out anything that can be explained through Nature and human activity. We must not rush to declare all those "enigmas" of History that remain unexplained to this day as indisputable traces of extraterrestrial beings.

On the other hand, these hypotheses about Martians nourished the imagination of science fiction authors for decades.

ARE THE MARTIANS OUR ENEMIES?

Years have passed, and humans have not received any signal from the mysterious planet. They have not found a single confirmation of the existence of Martians on Mars.

The strange reddish globe gave no signs of life, always silent, yet "blooming" every spring. To those observing it through a telescope, it briefly showed the image of the inexplicable network of "canals," like a mirage that stimulates our imagination.

Humans did not cease their search. They supposed that something of exceptional and very interesting importance was hidden on the planet.

Man invented what he couldn't decipher. So, he imagined and created a Martian world to his liking.

It would be good if Martians existed. But several questions arose: What would they be like? Kind and benevolent, or unpleasant and cruel?

On Mars, we would want to find friends, not mortal enemies.

What will our encounter be like? Friendly or hostile? Would it be better to stay away from that planet? It could be the lair of a monster that it would be better not to disturb.

The scientists said nothing about it. They had no answer to these questions. However, science fiction authors offered different versions regarding our supposed neighbours in the Cosmos. Each gave their own version.

In England, at the beginning of our century, the writer Herbert Wells lived. England and the surrounding countries are capitalist, where the law of the strongest prevails. Wells surely thought the world was the same everywhere, on all planets.

Therefore, when Wells wrote a science fiction book about the Martians, he titled it *The War of the Worlds*.

It is an excellent book. But it is terrifying. When you are a little older, read it. Now I will tell you what the book is about.

Astronomers all over the world, observing Mars through their telescopes, noticed a strange flash. It looked as if an enormous cannon had fired towards Earth. Exactly one day later, it happened again. Then again and again. And so on, ten times in a row.

No one paid it any mind. They forgot about the flashes, because it wasn't possible for there to be a cannon on Mars, much less one firing at us. Nonsense, fantasy, people said.

Life on Earth continued its normal course.

But... *"And the night came when the first meteor fell. It was seen in the early morning; it passed over Winchester, heading East. A very high line of fire. Hundreds of people watched it, believing it to be a shooting star, identical to the others..."*

Early in the morning, the most curious people went to look for the stone that had fallen from the sky. On the outskirts of the city, not far from the sand quarries, they found a gigantic funnel.

"...The Thing lay, almost completely buried in the sand, among the scattered fragments of a pine tree shattered in the fall. The exposed part had the appearance of a colossal cylinder, with a baked crust..."

People gathered around. Astonished, they observed the strange black apparatus from the edge of the pit.

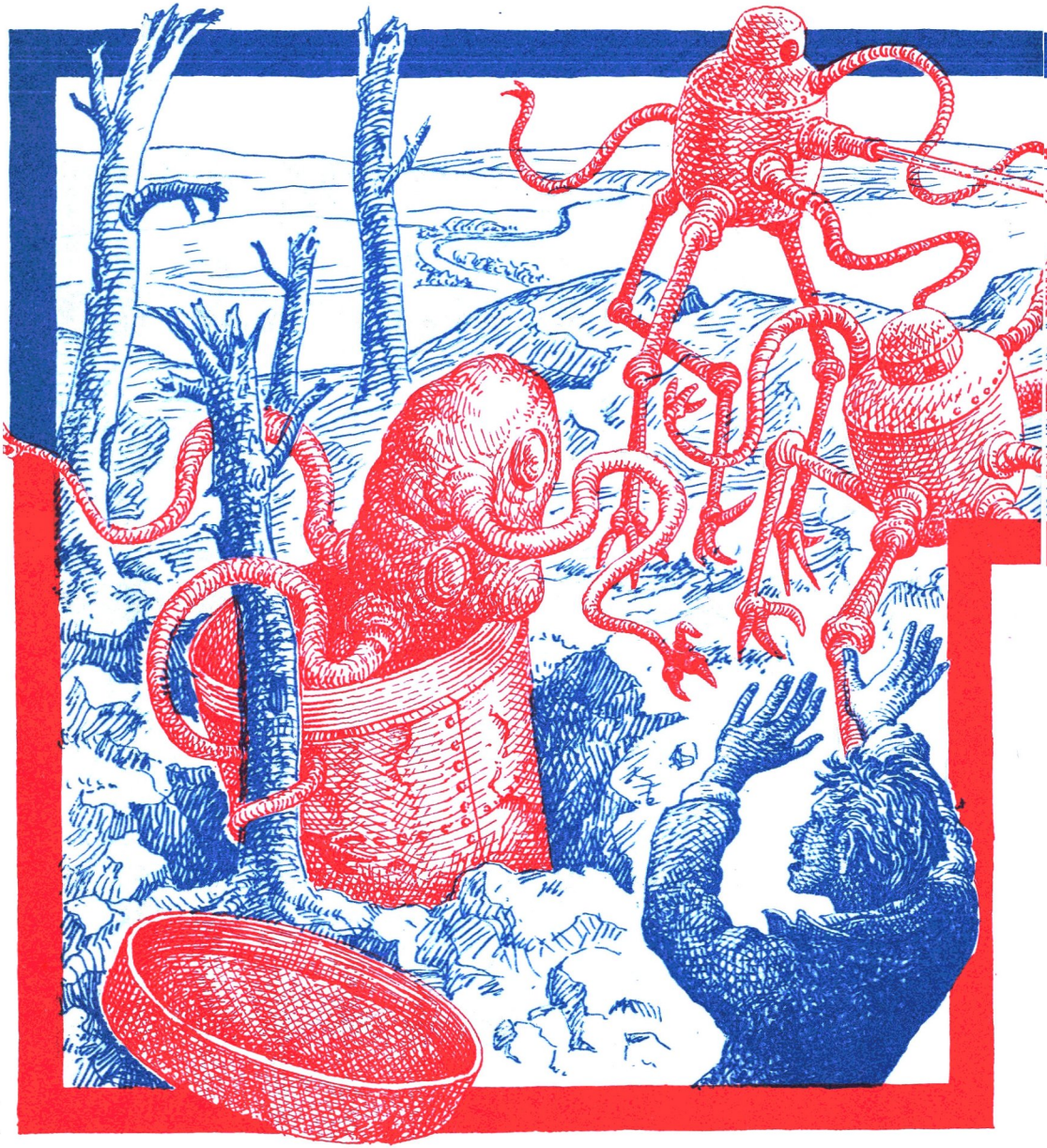
Suddenly, everyone shuddered. They watched as the round roof of the apparatus began to turn slowly.

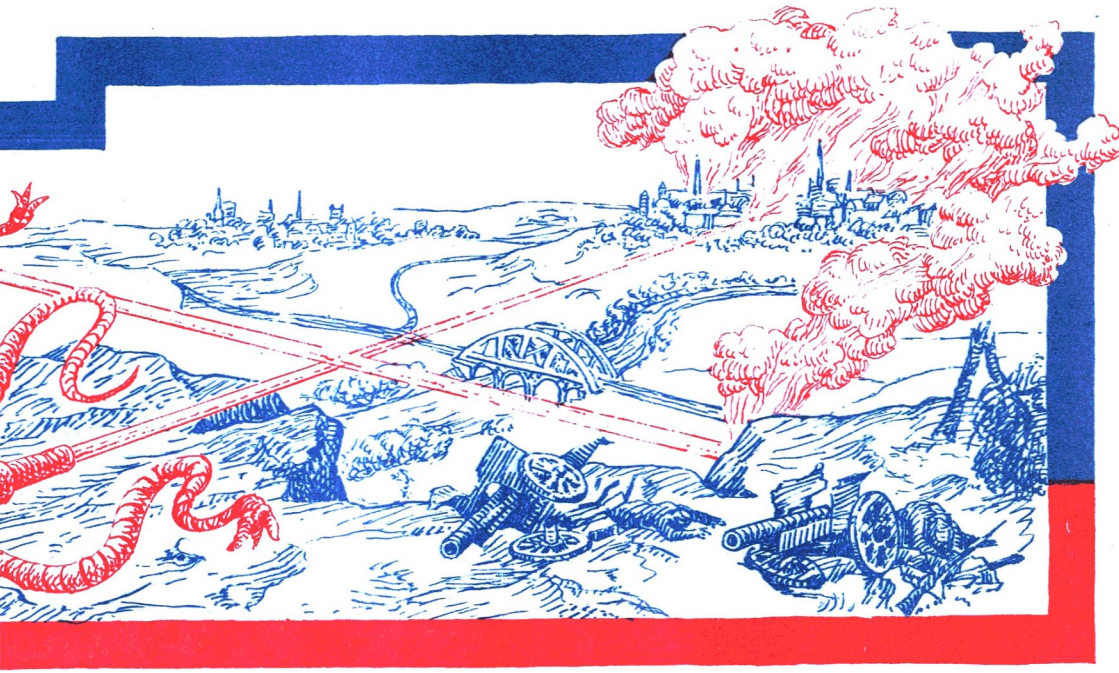
Curiosity overcame fear. The people didn't have the strength to move and stood motionless, holding their breath, while observing the mysterious apparatus...

Wells wrote the book in the first person. His hero participates directly in the events and recounts what he saw and experienced in those days. This is how he describes what appeared before him when he approached the edge of the pit:

"*...The lid was unscrewing itself. Half a metre of the gleaming thread was already visible. Someone pushed me, and I was about to fall onto the cylinder. I turned around, and then the unscrewing must have finished, because the lid fell onto the rubble, the drop producing a metallic sound...*"

"*...I imagine that everyone expected to see a man emerge, perhaps a being in some way different from us, but a human being. That is what I expected. Looking intently, I soon saw something moving in the shadow, with uncertain, undulating movements, one on top of the other. After a while, two luminous discs stood out, perhaps two eyes, and something like a grey, thick snake, like a cane, unfolded from a convulsive body to writhe in the air, close to me. And this twisted thing* was *followed*





by another, and another..."

"*I shuddered violently...*"

"*...A greyish, round mass, the size of a bear, slowly and laboriously rose out of the cylinder. When the full light hit it, it shone like damp leather. Two colossal dark eyes stared intently at me... A thin, soft, tentacular appendage grasped the edge of the cylinder, and another swayed in the air...!*"

"*...all this gave me a sensation similar to nausea... I felt overwhelmed with disgust and fear...*"

A day passed. Night came.

Men tried to initiate peaceful conversations with the terrifying extraterrestrials, raising white flags for this purpose. But the Martians paid no attention to the people. They just moved

around in their pit.

However, afterwards...

"*...Suddenly a flash occurred, and a luminous, greyish smoke came out of the pit in three distinct puffs which disappeared, one after the other, in the still air.*"

"*At the same time, a whistling sound began to be heard...*"

"*Slowly the whistle turned into a buzzing, and the buzzing into a loud, constant shriek. And, slowly, a shape with a huge hump rose out of the pit, and from it timidly emerged the spectre of a beam of light.*"

"*And immediately, real flames and bright flashes sprang up in the scattered group of men, leaping from one to another. It was as if some invisible jet had reached them, producing white flames upon impact. It looked as if every man was suddenly turned into fire.*"

"*In the light of their own destruction, I saw them stagger and fall.*"

"*Those who followed them began to run...*"

The people understood that they were facing a cunning and ruthless enemy. All who survived fled. The countryside was abandoned.

By that time, new Martian apparatuses were arriving on Earth. One of them landed every morning. Do you remember the ten flashes that the astronomers observed on Mars?

The government sent the army to the regions where the apparatuses were landing. But what kind of army was this? At that time, there were no aeroplanes, no tanks, no rockets; only ordinary rifles and very simple cannons.

The soldiers surrounded the Martians and waited expectantly.

The Martians unhurriedly assembled strange machines in their pits, very different from anything seen on Earth. They were enormous three-legged tripods with an armored cabin on top, inside which a Martian operated the machine. The tripod advanced, moving each of its three legs in turn. This is how the Martians emerged from their pits. The terrifying tripods were striding across the Earth.

Panic spread. People began to abandon their homes and run aimlessly.

Wells's hero did not have time to flee. This is how he describes his first encounter with the Martian machines.

"*...A monstrous tripod, taller than several houses, strode over the young pine trees, crushing them in its path; this mobile machine, made of polished metal, advanced through the undergrowth; steel cables hung from its articulated flanks, and the deafening crash of its steps mingled with the rumbling of thunder. In the light of a flash of lightning, it stood out clearly with one foot on the ground and the other two in the air. It disappeared and reappeared instantly. At the next flash of lightning, I saw it a hundred meters closer to me...*"

"*...(It was) a machine with a mechanical, metallic-sounding step and long, flexible, gleaming tentacles...*"

"*...As it advanced, the machine was choosing its path. The bronze cowl that crowned it at the top moved in every direction, like a head looking around...*"

The war against the Martians began.

The English soldiers attacked bravely. But the Martians finished them off before they could open fire. The terrible machines passed over every obstacle. They appeared unexpectedly in any location and, aiming their horrible "heat ray," incinerated everything in their way. Villages, cities, and forests burned; flames scorched everything around, and everything was covered in black smoke.

The people, panic-stricken, ran along the roads. Wells's hero also fled with the others. He describes an episode where the crowd, horrified and having lost their reason, was crossing a river:

"*...Quickly, one, two, three, four Martians appeared in their armour. They were still far away, beyond the trees, in the meadows stretching towards Chertsey, and they were heading rapidly towards the river... The one on the far left, the furthest away, raised as high as he could a kind of colossal casing... and immediately the phantasmal and terrible Burning Ray, which I had already seen on Friday night, sprang forth towards Chertsey and attacked the town...*"

"*...the crowd huddled on the banks seemed seized by terror...*"

"*...But then the Martian's machine was as concerned with the people running here and there as a man would be who had stirred up an anthill with his foot. When, half-drowned, I raised my head, the Martian's cowl seemed to be intently* examining *the*

batteries firing across the river. It advanced, letting what must have been the casing generating the Burning Ray sway under its weight."

"*A moment later it reached the bank, and with a single stride almost crossed the river; the joints of its front feet bent as they touched the opposite bank; but immediately, upon entering Shepperton, it regained its full height. At that moment, the six cannons, unknown to everyone, hidden at the end of the town, fired simultaneously. The blasts made my heart jump. The monster was lifting the casing that generated the Burning Ray when the first shell exploded about six metres from its cowl.*"

"*I let out a cry of astonishment... At the same time, two more shells exploded in the air, near the Martian's body, and it did not have time to dodge the fourth shell.*"

"*This one burst open, the cowl split open, jumping away in pieces...*"

Despite some isolated successes, the English army suffered progressive defeats. The Martians were merciless: they directed their heat ray towards the cannons and destroyed them immediately, without letting them fire. They launched bombs that released a thick, heavy black smoke which suffocated the men.

The Martians proved to be stronger than the Earthlings. And they had no compassion. They could easily destroy all of humanity, just as we get rid of bedbugs and cockroaches.

The cities were abandoned; the flourishing valleys turned into dead deserts; the villages succumbed to the fires.

The English army was destroyed. It was useless to continue resisting. The people understood their powerlessness.

Suddenly, for some inexplicable reason, the Martians lessened the intensity of their attack, until they ceased fire entirely. The terrifying tripods no longer walked through the fields and cities, sowing death and desolation. They remained motionless, and only strange moans could be heard, which later faded away.

When people dared to approach, it was confirmed that all the Martians had died. They died from contagious diseases against which they did not know how to fight.

The people returned to their cities, rebuilt the houses the Martians had burned, and replanted the ravaged gardens. Life was then able to return to its normal course.

This is how Wells ends his extraordinary book about the Martians.

ARE THE MARTIANS OUR FRIENDS?

The Soviet writer Alexéi Tolstói also wrote about the Martians, but he saw them through different eyes.

He wrote his book *Aelita* after the Great October Socialist Revolution. Not much time had passed since the people had overthrown the capitalist power. A new, prosperous life was being forged on the basis of common understanding and mutual aid.

No one had ever seen the Martians, and logically, one could only imagine them as similar beings. The mysterious inhabitants of the "red planet" should mostly be good and be our friends.

Aelita is a book for adults. Below is a summary of its content:

In the city of Petrograd—now Leningrad—lived an engineer named Loss who built a large rocket. He took as an assistant a brave, skilful young man with exceptional manual ability. He was a reserve soldier named Gúsev.

They built their rocket in a shed on the banks of the Zhdánovka River. On a dark August night, piercing the shed's roof, two daring men took flight toward Mars. They made the journey and landed without incident. Suddenly, upon exiting the ship, they noticed that everything around them was desert; only reddish cacti were visible. They wandered around the vicinity. Later, they felt a strange tiredness that forced them to fall asleep right there, in the middle of the desert.

They had been detected by one of the local inhabitants who

informed the other Martians. The Martian Tsar, Tuskub, came to greet the Sons of Heaven.

Alexéi Tolstói narrates the following to us:

"*...Loss and Gúsev were woken up by a loud noise of propellers...*"

"...Clouds, a blinding pink, like burning skeins, covered the morning sky. An airship would appear in the clearings of deep blue as soon as it disappeared among the rosy, sun-drenched clouds. Its framework, with three masts, resembled a giant beetle. Three pairs of sharp wings jutted out from its sides."

"*The ship sliced through the clouds and, damp, silvery, and gleaming, hung suspended between the cacti. Powerful propellers roared on the wings of its short masts, preventing it from descending. Ladders were lowered from the sides, and the ship landed on them. The propellers stopped.*"

"The frail figures of the Martians quickly descended the ladders..."

"*...Loss stood with his arms crossed over his chest and smiled. The last one to descend from the ship was a Martian dressed in a black robe that fell in large folds. His uncovered head was bald and bumpy. His narrow, beardless face was an ashy blue colour.*"

"*Stumbling on the soft ground, he walked along the double row of soldiers. His bulging, clear eyes, with a cold stare, fixed on Gúsev. Then he looked at Loss. He approached them, raised a small arm tucked into a wide sleeve and said, in a thin, slow, and clear, bird-like word:*

"*–Taltsetl.*"

"*His eyes widened even more, and a cold excitement lit up within them. He repeated the word and pointed authoritatively at the sky. Loss said:*"

"*Earth.*"

Tuskub invited the Earthlings to board his ship and they went together to his palace.

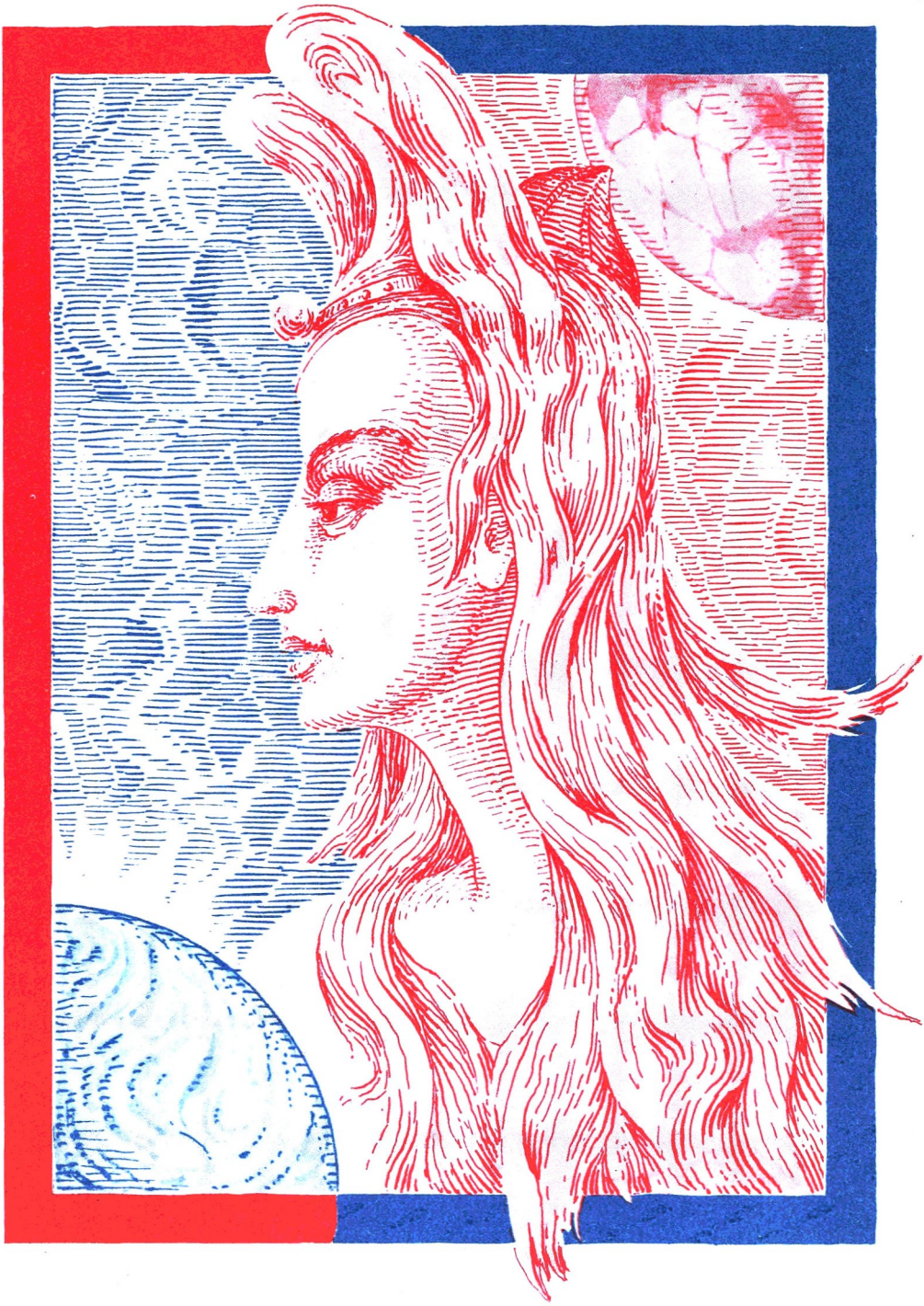
The Earthlings then learned that the Martians were their relatives. A very long time ago, on Earth, in the great Atlantis, lived a tribe of Atlanteans. They were much more developed than other peoples on Earth, highly cultured, and knew how to do many things.

The island succumbed due to strong earthquakes. It sank into the sea. The ocean waves wiped out all its cities and almost all its inhabitants. Only some of the Atlanteans were able to save themselves. In rockets, they flew from Earth to Mars.

At that time, Mars was already inhabited by weak and very primitive beings. When those powerful giants arrived from Earth, they welcomed them and called them "Magatsitls," then immortalized them in statues.

The Magatsitls had intermingled with the Martians. The current Martians are their descendants, that is, relatives of the Earthlings. In their legends, the Magatsitls expressed their nostalgia for their distant homeland: Earth.

Continuing to read:
"*...The ship descended, flew through a gorge, and landed in a meadow that sloped gently toward some dark and dense* thickets.



"*Loss and Gúsev took their backpacks and, together with their bald companion, walked down the meadow toward a grove.*"

"*The path curved towards the lake. Its dark blue mirror appeared with the reflection of the summit of a distant rocky mountain. The reflection of weeping trees swayed gently in the water. A magnificent sun shone. In a cove on the shore, on either side of a moss-covered staircase that descended to the lake, two enormous seated statues stood, cracked and covered with climbing plants.*"

"*On the staircase a young woman appeared. She was wearing a pointed yellow cap. She wore a blue and white dress, and the slenderness of her body contrasted with the Magatsitle, which looked covered in moss and eternally smiling in its sleep. The young woman slipped, grabbed a stone ledge, and raised her head.*"

"'Aelita,' whispered the Martian, covering his eyes with his sleeve, and he took Loss and Gúsev to the small woods..."

After the journey, Loss and Gúsev were left to rest. In the morning, they were told that Aelita, Tuskub's daughter, wished to see them. They were led to the door of Aelita's room, and the Sons of Heaven timidly entered a long, white room.

"*...Rays of light with volatile dust particles fell through the skylights in the ceiling onto the mosaic floor, which reflected rows of books, bronze statues that rose between flat cabinets, small tables with thin legs, and frosted mirrors of some screens.*"

"*Not far from the door stood a young woman with ash-coloured hair, a black dress buttoned up to the neck and wrists. Dust motes danced on her high hairstyle.*"

"*She was the young woman whom the Martian had called Aelita the previous day by the lake.*"

"*Loss greeted her with a deep bow. Aelita, without moving, looked at him with the enormous pupils of her grey eyes. Her long, ashy-blue face was trembling. Her slightly turned-up nose and somewhat elongated mouth had a childlike delicacy...*"

" *'Ellio utara gueo—' the young woman pronounced in a voice that was sweet, light, like music, almost whispering, and she bowed her head so low that her nape was visible.*"

"*In response, Loss merely cracked his fingers.*"

"*Making an effort, he said in an incomprehensibly emphatic tone: '-The ones arrived from Earth, greet you, Aelita.'*"

"*...She held out a hand with the palm facing upwards. Almost immediately, Loss and Gúsev saw a pale green, opaque ball in it, the size of a small apple. Something was moving and shimmering inside its sphere.*"

"*The guests and Aelita attentively watched the misty, opalescent-reflecting apple. Suddenly, its currents stopped and revealed dark patches. Loss cried out: the globe of the Earth lay in Aelita's hand.*"

" *'Taltsetl—' she pronounced, pointing with a finger.*"

"*The small sphere began to rotate slowly. The contours of America, the Asian Pacific coast appeared. Gúsev was excited:*

'That's us, us, the Russians—' he said, pointing a finger at Siberi-

a,"

It is not known how that marvellous globe was constructed. But it truly possessed magical properties. One could, for example, clearly remember any place on Earth, and that place would appear on the globe, like a picture appearing on the screen of a tiny television.

Aelita asked Loss to remember Earth, and he showed her, on the marvellous globe, Petrograd, his native city, its embankments, bridges, the people and the houses where they lived, and street scenes. He explained the scenes with words. Thus, little by little, Aelita learned from the guests what Earth was like, how people lived there, and she learned to understand the guests, and vice versa.

Aelita and Loss enjoyed talking. He looked for her everywhere.

A true and great friendship was born between Loss and Aelita. They fell in love. And without telling Tuskub, they got married.

At the same time that Loss and Aelita became friends, Gúsev met Igoshka, Aelita's cheerful maid. Through their conversations, he learned how the Martian people lived. There, as on Earth, the planet was divided into the oppressed and the oppressors.

The oppressed, who were the majority, held friendly feelings toward the Earthlings. This is how Gúsev decided to help them in their struggle for freedom.

Of course, all this enraged Tuskub. It was unacceptable to him that one of the Sons of Heaven had entered his palace as his daughter's husband and was now possibly intervening in

Martian affairs, while the other Son of Heaven was stirring up the people. Where would all this lead?

To secure his rule, Tuskub decided to eliminate the guests and also his daughter, for having dared to marry the Son of Heaven without his permission. He ordered her to be thrown into a deep pit.

Tuskub's men found Aelita and Loss. They tried to capture them. But since Aelita knew they were both going to die, she drank half a poison and gave the other half to Loss, who, as soon as he took it, lost consciousness.

Loss recovered in the rocket already on the way back to Earth. Gúsev had snatched him from the Martians, carried him to the ship, and departed.

What happened to Aelita? Loss never knew. Was she alive? Did she die from the poison? Or was she suffering at the bottom of the pit?

Loss was living on Earth again, but he had no peace. He was sad and walked around like a tormented soul. Where was his friend? Where was Aelita?

One winter day, Loss was urgently called to the radio station. They explained that for several days now, precisely at seven in the evening, certain mysterious and strange signals had been heard. Some people supposed they were coming from Mars.

"*...Loss sat before the receiving apparatus and put on the headphones...*

"*A slow whisper was heard in the headphones. Loss immediately*

closed his eyes. Again the slow, distant whisper sounded, full of anxiety. It repeated a strange word. Loss strained his ear. Like a soft ray, the voice from the distance penetrated his heart, repeating sadly in an extraterrestrial language:

"*Where are you, where are you, Son of Heaven?*"

It was the voice of Aelita. Loss understood that she was alive! That she was looking for him!

This man has a friend on the distant planet, a faithful and beloved friend. How wonderful, isn't it?

If two people have managed to become friends, it won't be difficult for thousands or millions of others either. Invisible threads of friendship will unite the planets and their inhabitants. Earthlings and Martians will help each other. The Universe would be crossed by warm and encouraging messages.

WE MUST FLY TO MARS!

Herbert Wells and Alexéi Tolstói are science fiction authors, and despite the beauty and appeal of their narratives about the Martians, we all know they are nothing more than inventions and that, in reality, no engineer Loss existed in Petrograd and no one ever shot at London from Mars.

By the end of the 1950s, no one gave credence to the existence of "Martian-men" anymore. Lowell's hypothesis, which the dreamers so ardently defended, did not last long. The sceptics triumphed.

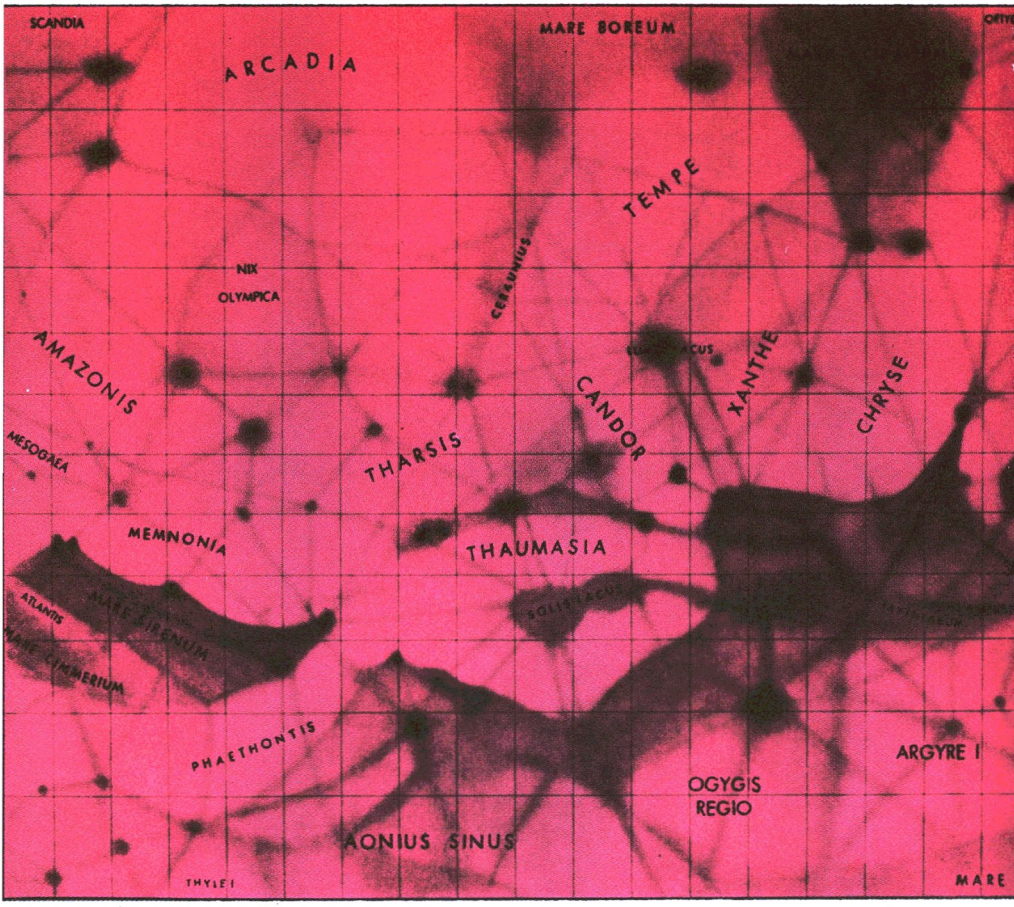
However, there were still hopes of finding "Martians." Discussions arose again between two groups. The dreamers thought that on Mars there would only be plant and animal life. The sceptics, this time, only accepted the possibility of "Martian-microbes" existing there.

If plants abound, we might manage to see them through a telescope; on the other hand, we could never see microorganisms, not even in the palm of our hand. In other words, the telescope was already insufficient to continue the search for life on Mars.

The study of the planet Mars was paralyzed for a time.

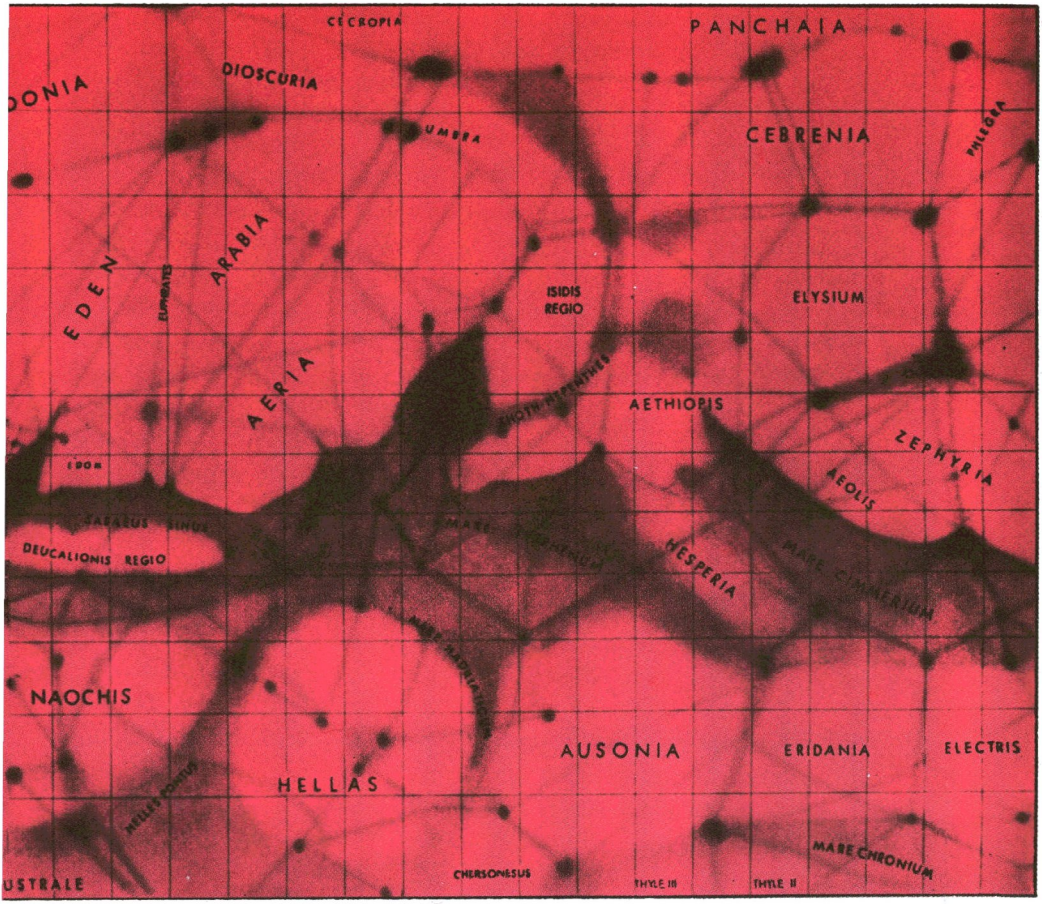
But not much time passed before the first cosmic rockets appeared. There were new opportunities to study Mars "on the ground," by first sending automatic spacecraft in its direction.

Let's remember how flights from Earth to other planets are carried out.



There is no known route between Mars and Earth. No roads for travel, no water for sailing, and no air for flying an aeroplane. Between Mars and Earth, only the empty, interplanetary space—the Cosmos—reigns.

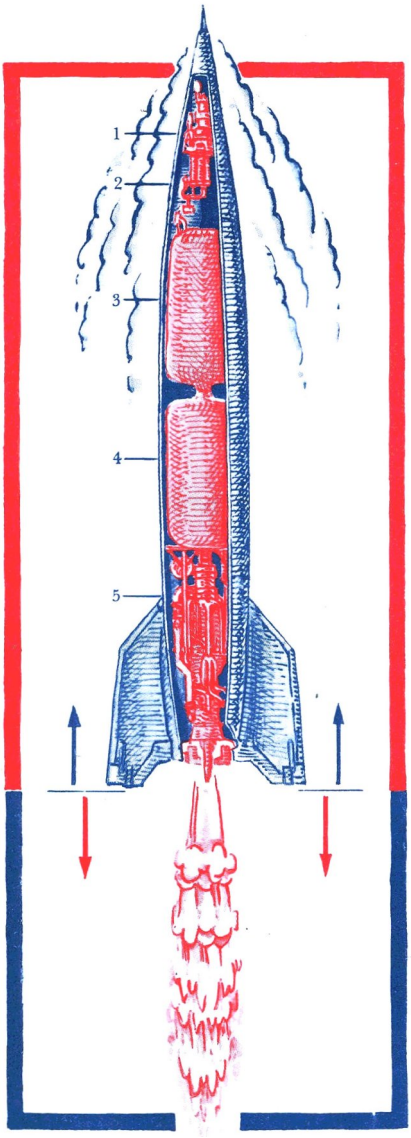
We can only reach Mars if we "jump" towards it. To "jump," you must "take a running start" at a high speed. It is impossible to move as fast as necessary in the air. The air offers resistance, like seawater when we dive. Therefore, we must first reach the vacuum, and once there, accelerate until the necessary speed is achieved.



This is a map of Mars created before the flights of automatic interplanetary stations. It features names of some elements of the Martian surface; the main "canals" are traced.

The North is at the top and the South is at the bottom, just like on terrestrial maps.

The eminent Russian scientist Konstantín Tsiolkovsky assured that this problem could only be solved by using a space rocket, since it does not need wings to support itself in the air and can move in a vacuum.

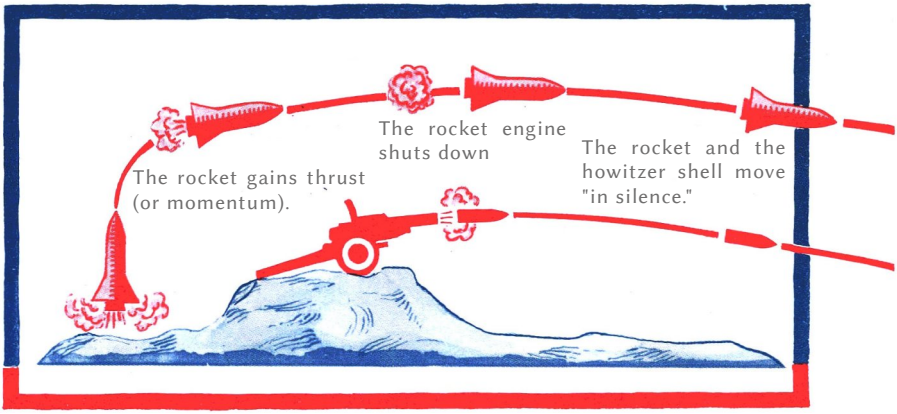


Rocket Structure. 1 - payload 2 - flight control section 3 - fuel (fuel tank) 4 - fuel (oxidizer tank) 5 - propulsion system

The rocket is equipped with an engine shaped like a narrow-necked bottle. Inside it, liquid and atomized fuel is burned. Hot gases exit the neck. The fuel passes into the "bottle" through a large number of tubes. It is burned there with colossal force. Many gases are formed. Pushing with great momentum, with a deafening roar and supersonic speed, the gases exit the neck of the “bottle” in flames. As they exit the “bottle,” the gases push it in the opposite direction.

The “bottle” is located in the tail of the rocket, with the neck facing backward. That is why the gases propel the rocket forward. It flies, spitting out a jet of fire with a great roar. It does so faster and faster, until the fuel runs out or the engine stops being fed. Even though the thrust ceases, the rocket does not stop; it continues to fly by inertia.

Let's compare the rocket launch to the firing of a cannon.

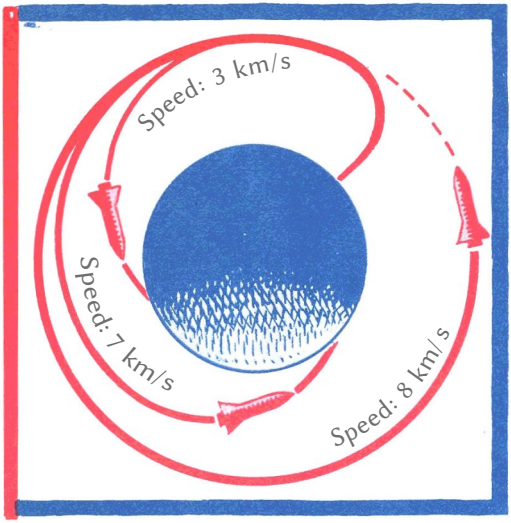


In both cases, an initial impulse is needed, from which they will fly for a long time "in silence" toward where they have been launched.

The projectile gains momentum in the cannon, in a very short time, in fractions of a second. The rocket does so directly during flight, and more slowly, over several minutes. In the case of the rocket, "the shot" is prolonged.

There is also a difference in the path followed. The projectile gains momentum in a straight line inside the cannon and follows the direction the cannon gives it. The rocket, on the other hand, can be propelled along a curved line and launched upwards. Once it is in space, during the flight, it is turned in the desired direction.

First, it is oriented in a specific direction, then it is propelled, gaining speed. At the opportune moment, the engine is turned off, and its flight will no longer have any difference from that of the projectile fired by the cannon. Both will fly by inertia, "in silence." The Earth's gravitational force deflects their trajectories into a curved line.



What is the necessary velocity to propel the rocket? The faster an athlete is propelled, the longer their jump will be. The same happens with the rocket. The greater the force in the thrust, the greater its trajectory. Look at the drawings. If we propel a rocket with a velocity of three kilometers per second, the engine will stop, but the rocket will advance like a projectile. The Earth's gravity diverts its trajectory and the rocket descends. If the next rocket is propelled by a velocity of seven kilometers, the jump will be thousands of kilometers long.

If we apply a thrust of eight kilometers per second (8 km/s), the rocket will fly surrounding the entire terrestrial globe. At high speed it is difficult to turn it because it will fly off course, just as a car leaves the road on a curve. No matter how great the force of attraction exerted by the Earth to bring it back, it will never succeed.

Do not forget that the on-board engine only operates while gaining thrust. And now the rocket flies around the Earth "in silence." Since there is no air at such an altitude, nothing slows it down. It can no longer be stopped. Its trajectory has closed into a circle.

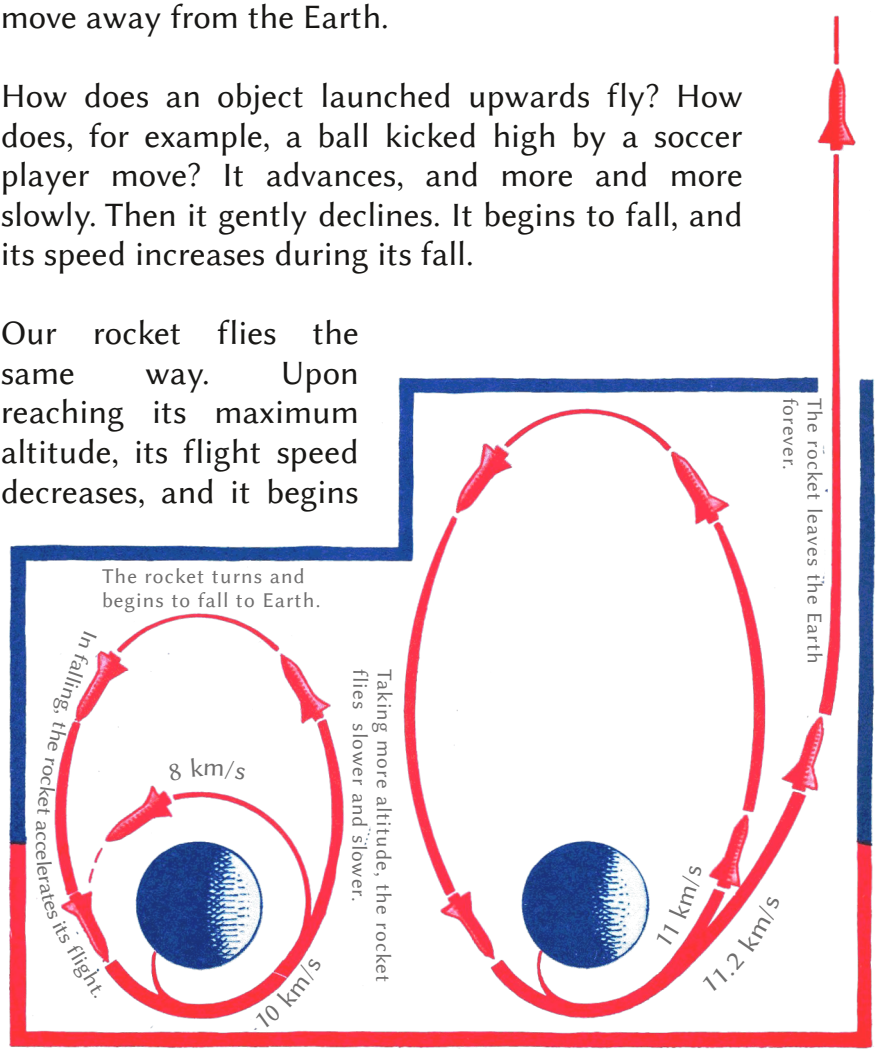
The rocket has become an Earth satellite. It flies at a speed of

eight kilometers per second (8 km/s), which is called *"the first cosmic or circular velocity."* Today, Earth's satellites, cosmic ships, and orbital stations flown by our glorious cosmonauts move in these circular orbits.

And what happens when the rocket is propelled with a greater force? For example, up to 10 km per second (10 km/s)? It will be even harder to bring it back and it will gradually move away from the Earth.

How does an object launched upwards fly? How does, for example, a ball kicked high by a soccer player move? It advances, and more and more slowly. Then it gently declines. It begins to fall, and its speed increases during its fall.

Our rocket flies the same way. Upon reaching its maximum altitude, its flight speed decreases, and it begins


The rocket turns and begins to fall to Earth.
In falling, the rocket accelerates its flight.
8 km/s
10 km/s
Taking more altitude, the rocket flies slower and slower.
11 km/s
11.2 km/s
The rocket leaves the Earth forever.

to turn to descend faster towards the Earth.

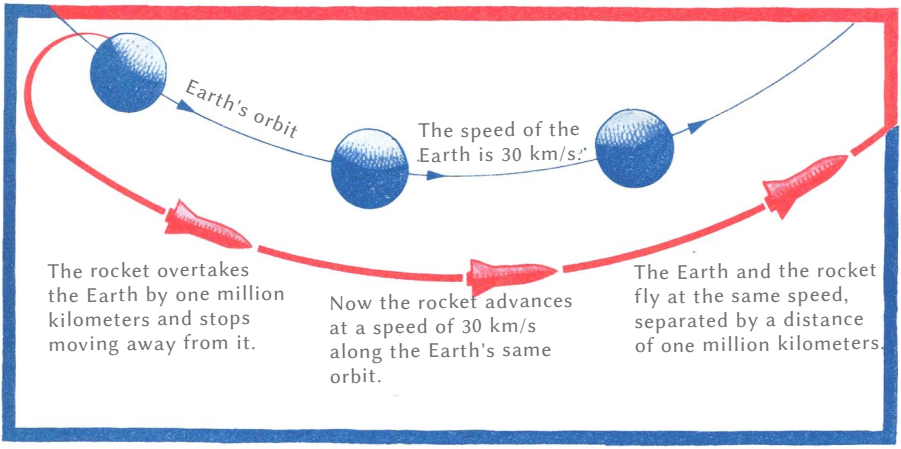
Its speed increases again up to 10 km per second (10 km/s). The rocket heads towards the Earth, but without hitting it, it moves away again toward the cosmos.

It's called an *"elliptical orbit"* for this rocket, because its trajectory has the shape of an ellipse.

If the rocket is propelled at a velocity of eleven kilometers per second (11 km/s), its elliptical orbit will be elongated to half the distance between the Earth and the Moon. However, the rocket, in the end, turns and returns.

A very different result will be obtained if the so-called *second cosmic velocity (or escape velocity)* of 11.2 km per second (11.2 km/s) is used.

The engines are turned off, the device flies away from the Earth. It surpasses the distance between the Earth and the Moon. It moves away another equal distance... and a half

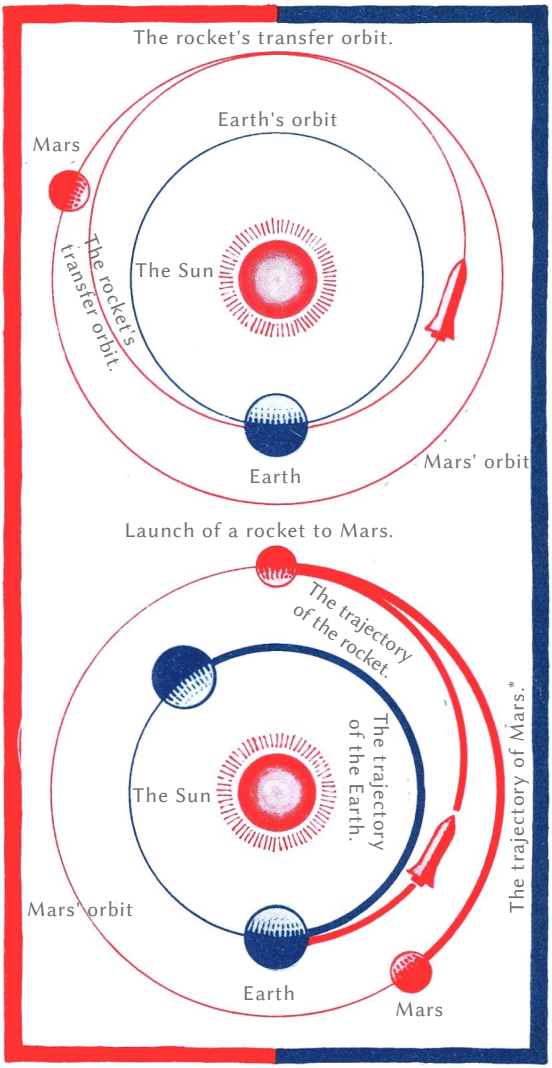

Earth's orbit
The speed of the Earth is 30 km/s.
The rocket overtakes the Earth by one million kilometers and stops moving away from it.
Now the rocket advances at a speed of 30 km/s along the Earth's same orbit.
The Earth and the rocket fly at the same speed, separated by a distance of one million kilometers.

more, reaching one million kilometers from our planet. The rocket exhausts its thrust. Its flight is slower and slower... But... it does not turn back like its predecessors. It does not fall back to Earth. It has gone so far that Earth's gravity can no longer reach it.

From Earth, it cannot be seen, not even through a telescope. If we could, we would see it hanging at a point in space, as if from a nail, because it is neither approaching nor moving away from us.

In reality, the rocket is moving. It flies along the Earth's orbit around the Sun. The velocity of both is equal, that is, 30 kilometers per second (30 km/s). This is the velocity at which the Earth rotates.

Let's launch another rocket at a greater velocity. When it moves away from



*in the course of the rocket's flight.

the Earth to a distance of one million kilometers, it will have a velocity greater than 30 kilometers per second (30 km/s). Now, with this velocity, it will no longer remain in the Earth's orbit and will begin to "climb" toward the orbit of Mars.

The velocity of the rocket can be calculated from the launch itself, such that it "ascends" to the Martian orbit, touches the terrestrial orbit on its descent, and "ascends" again to the Martian one. It will fly along a *"transitory elliptical orbit."*

Through this, one can move from the terrestrial orbit to the Martian one. But this is not enough for us. We must move from one planet to another. We know that a planet is just a mobile point in orbit: it is therefore necessary to fly to Mars' orbit when this planet comes into the path at that very point. An "encounter at the agreed-upon point" must happen. Neither the rocket nor the planet can wait.

Therefore, when going from one planet to another, it is necessary to calculate the encounter with great precision. Suitable conditions for flying to Mars, during the "opposition," only occur once every two years.

As you can see, flying to Mars is possible, but difficult.

IS IT DIFFICULT TO REACH MARS?

And why should it be difficult? If we do everything correctly—take off, propel ourselves, and enter the orbit—we could sleep peacefully for half a year. We would move along the orbit as if on sure rails and reach the goal.

But, it's not that simple. Calculating the exact orbit and getting the rocket to enter it is a very difficult task.

Let's imagine the following: we take off, cross the atmosphere, and exit into the Cosmos.

Below, we have left the globe; now, the black sky, full of stars, surrounds us. Among them is a reddish, brighter star, well known to us. It is Mars; we have seen it.

What should we do now? Point the rocket directly toward the planet?

That would be impossible. We know that in the Cosmos, one does not fly in a straight line. One flies along orbits, which are all curved. Furthermore, Mars is not going to wait for us at the same point.

The calculations must ensure that the rocket and the planet, describing giant arcs in the Cosmos, meet at a determined point half a year later.

This is a very complicated calculation that scientists have learned to do. For this, they use computers and then inform the engineers when they can launch the rocket and where they must direct it exactly. This refers to a point in the vacuum,

which the rocket will reach by moving along its orbit. The rocket will behave as expected only if it is launched with the adequate velocity. If it flies at a speed greater than calculated, it will make a turn that is too steep and will miss. If it does it a little slower, the curve described will be wider than necessary, and it will miss equally.

Great accuracy is also needed during launch. To cross the atmosphere faster and exit "free" into the Cosmos, the rocket always takes off in a vertical direction. And only once it has reached the Cosmos does it gradually turn and head toward the chosen point. It is very difficult for the cosmonaut to steer the rocket at the moment of liftoff. The engines are working. Due to the rapid increase in velocity, the cosmonaut's body becomes heavy, and their hands do not obey them. Their ears ring. The time is reduced to a few counted minutes. At that moment, there is no time to look at the constellations, control so many devices, and determine the course. The rocket's direction is controlled with automatic devices from the moment of thrust.

The rocket's course and the moment when it must make the turn are calculated beforehand.

Inside the rocket, there is a device that indicates the turn "without looking outside." Just as a passenger traveling in a windowless car feels when and at what speed it takes curves. In the tail, there are small steering engines, with exhaust nozzles pointing in different directions. When necessary, the device turns them on, and during the liftoff, they steer the rocket for a few minutes by pressing on the tail from the sides.

How can one know if the adequate velocity has been reached?

First, it must be measured, which is not easy with the rocket flying in the Cosmos, where there is nothing but darkness and vacuum.

In the sea, the captain has no difficulties in this regard. The water rushes to meet his boat with the same speed the ship is moving. It is enough to immerse a small device with a propeller in the water, whose revolutions, when registered by it, will show the speed.

The same happens with an airplane, only air, not water, rushes to meet the airplane.

The problem lies in the following: *How to measure the rocket's velocity when no element rushes to meet it?*

Even so, it must be measured with great accuracy. In this case, there was no choice but to resort to devices that operate "without looking outside," which sense the increase in velocity, just like passengers in any enclosed transport perceive every acceleration. And once the desired velocity is reached, the engine is disconnected and turned off, intercepting the flow of fuel. The rocket continues its flight "in silence," meaning by inertia.

The launch was executed, and everything went well. The rocket took off, gradually increasing its velocity, and "broke through" the atmosphere. It turned gently in the Cosmos. It headed for the "point in the vacuum" that had been assigned to it. It reached the necessary speed and went silent.

Thus began a free flight that will last several months.

Now what? Can we relax now? Are we certain that the rocket

is moving along the set orbit?

No, it's impossible. A small error can always be made in the rocket's direction and launch. This will become apparent after a few days, when it is noticed that the rocket is deviating slightly from the pre-calculated path.

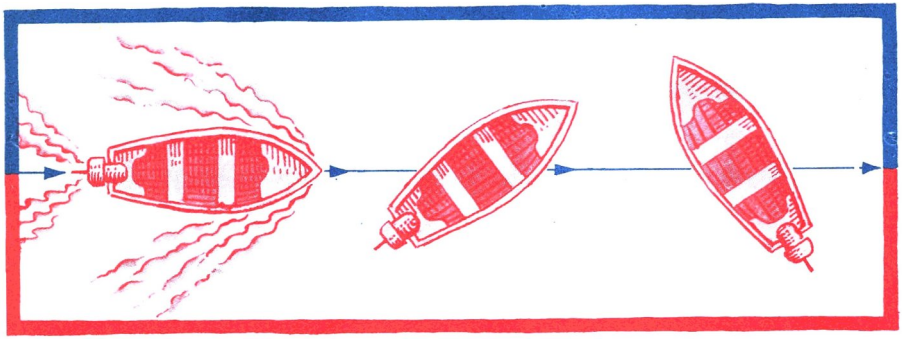
The rocket's flight is corrected en route. This is called *"trajectory correction."*

To understand this better, let's remember how a rocket flies.

The launched rocket can be compared to a motorboat moving in the water, propelled by the propeller spinning beneath the stern. The rocket, in turn, is propelled by the engine that expels jets of hot gases.

Both the bow of the boat and that of the rocket are sharp, to be able to cut through: the boat cuts the water and the rocket, the air.

Once the rocket has passed through the thickness of the atmosphere, it exits into the Cosmos and continues to propel itself in empty space. The sharp bow is no longer necessary.

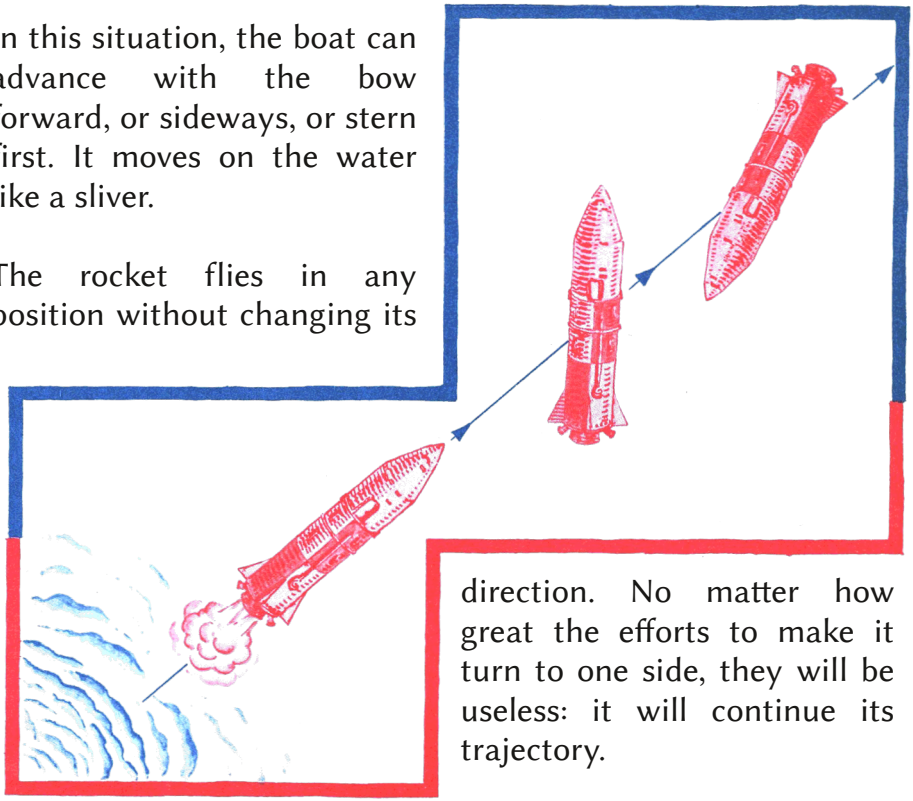


Now, it could fly at the same speed with a blunted bow.

The initial thrust has ended. The engine has been shut off. We can compare the rocket to a motorboat whose engine has been turned off and whose propeller has stopped in the middle of a swift river. The boat is carried by the current.

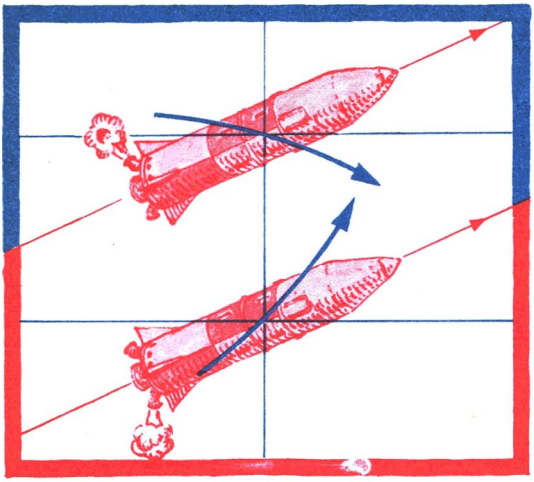
In this situation, the boat can advance with the bow forward, or sideways, or stern first. It moves on the water like a sliver.

The rocket flies in any position without changing its direction. No matter how great the efforts to make it turn to one side, they will be useless: it will continue its trajectory.



The direction of flight in the Cosmos can only be changed by giving the rocket a certain *thrust*.

Scientists and engineers found the solution. If the engine is turned on, it will push the rocket, which will turn, changing its direction of flight: precisely what we were looking for.



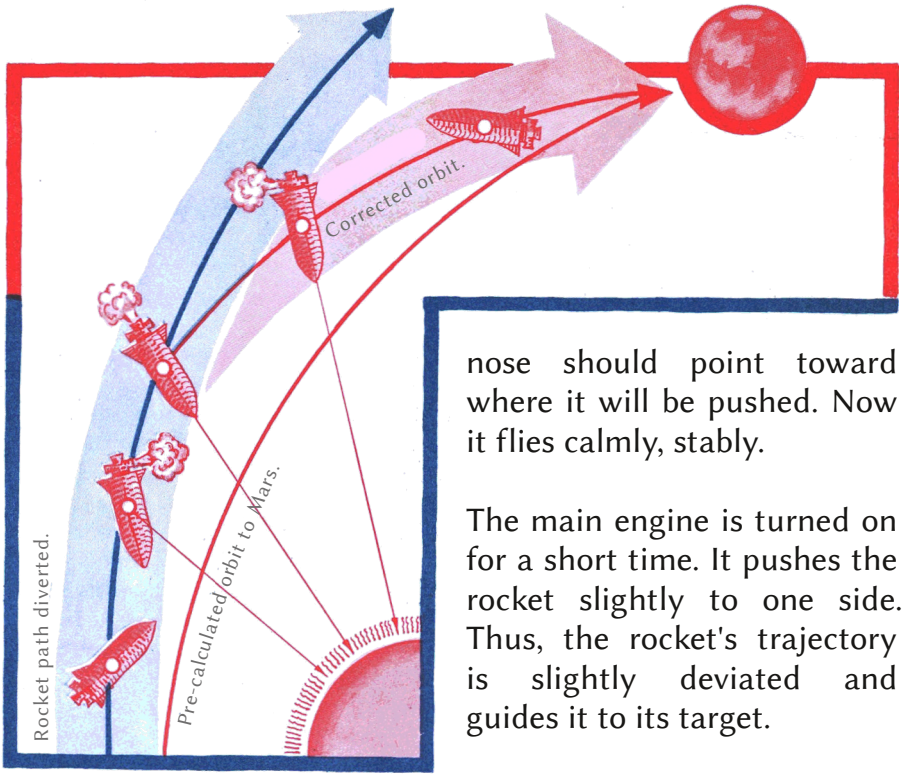
First of all, we must know, in what position is the rocket flying, in what direction is its tail: forward, sideways, or is it tumbling? By suddenly turning on the main engine, it will push the rocket anywhere, but it can also worsen the position.

This means that, first, it is necessary to stabilize the rocket so that it stops spinning, for which we must point its nose toward the necessary point and keep it fixed in that position. This is called "orienting the rocket." Only after this operation can the engine be turned on.

The rocket has special "orientation engines." These are small tubes with tiny holes at the tip. They emerge in different directions and fire jets of compressed gas. Each "shot" pushes the rocket's tail a little to the right or left, down or up. Through these small thrusts, the rotating rocket can be stabilized, and if it is flying normally, its nose can be directed in any direction.

In addition, the rocket has "capturing eyes." These rotate along with it to scan space. When the sought-after celestial body appears in front of them, the orientation engines turn on, with the help of which the rocket "latches onto," for example, the Sun, and continues flying, from that moment on "without taking its eye off" the celestial body.

Let's orient our rocket so that it advances sideways. And its



nose should point toward where it will be pushed. Now it flies calmly, stably.

The main engine is turned on for a short time. It pushes the rocket slightly to one side. Thus, the rocket's trajectory is slightly deviated and guides it to its target.

Of course, the force of the thrust must be calculated with great precision, so that it is neither insufficient nor too strong.

It's difficult to increase and decrease the engine's force. It's easier to turn it on and off temporarily. For example, it can be turned on for only five seconds, for one minute, or for five minutes. The longer the engine works, the greater the deviation of the rocket's trajectory toward the necessary side will be.

From Earth, the rocket can be directed during trajectory correction via radio. When a cosmonaut is traveling in the rocket, they can make the trajectory correction themselves, but with assistance from Earth.

When flying to such great distances as those that separate us from other planets, there are cases where trajectory correction must be done several times. Scientists have solved this complex problem, and today Soviet rockets almost always "hit the target" exactly.

Let's see what it means to "hit the target."

When the rocket approaches Mars, the planet's gravitational attraction pulls it, causing the speed of its flight to increase. Everything here will depend on the relative position of the rocket and the planet. If the rocket's trajectory collides with the planet, it will strike the surface at full speed. This is called making a *"hard landing."*

Or it may happen that the planet alters the rocket's trajectory, but not sufficiently, and the rocket then speeds past it with acceleration and, turning slightly, moves away forever toward any part of cosmic space, never to return.

What must be done for the rocket to become a satellite of Mars or perform a *"soft landing"* on this planet? For this, it is necessary to ensure the rocket flies stern-first (tail-forward). At the altitude of Mars, the engines are ignited, and the movement becomes a little slower. Mars, with its gravity, will sharply deflect the rocket's trajectory toward itself, and the rocket will begin to orbit the planet. To achieve descent, the speed is decreased again; thus, the rocket flying as a satellite will leave the orbit and begin to descend. Upon contacting the atmosphere, the speed will be reduced even further. It only remains to open the parachute and descend vertically. The descent will be soft if the engine is ignited again at the last moment. Now we see that, in effect, the path to Mars is difficult.

ON THE WAY TO MARS

You lot know that humans only learned how to fling rockets into space quite recently. The world's very first Sputnik — a Soviet satellite — shot off on 4 October 1957. And barely five years later, they set their eyes on Mars!

On 1 November 1962, from deep within Soviet territory, the automatic interplanetary station *Mars-1* blasted off on a rather ambitious expedition.

This clever contraption, affectionately called EIA for short, was a proper marvel of engineering, packed to the brim with gadgets.

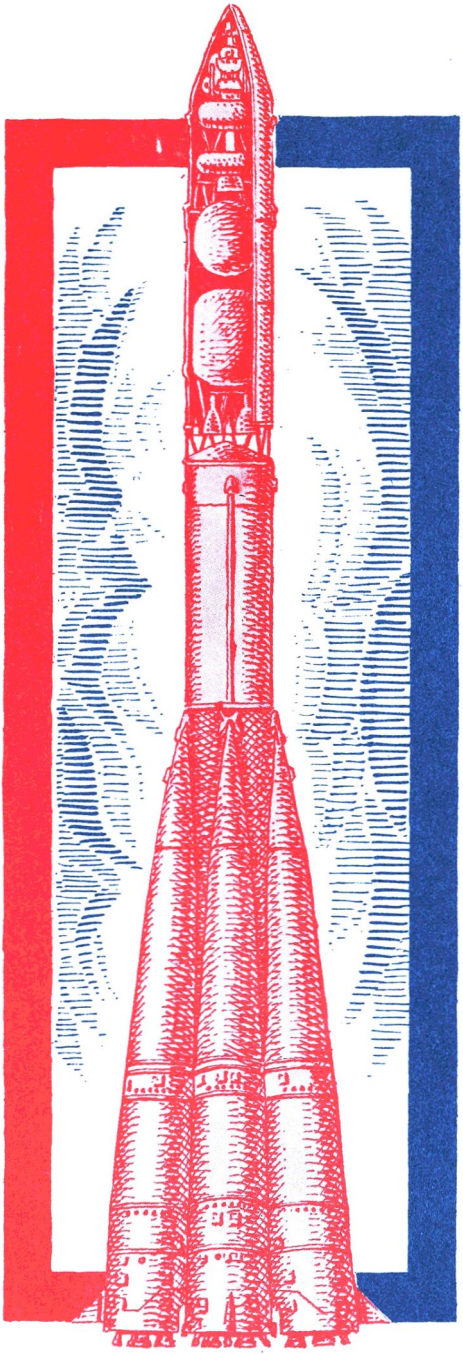
To keep on course, it had its own steering system and a tiny jet engine with a stash of fuel for mid-flight corrections. It chatted merrily with Earth through radio gear, carrying heaps of scientific instruments of every sort — even ones that could send home pictures from space!

Every gizmo on board needed power, of course, so it came armed with batteries and shiny solar panels.

The flight of *Mars-1* was planned to last seven and a half months — after all, the little spacecraft had to cover nearly five hundred million kilometres!

On 21 March 1963, it was already 106 million kilometres away from us.

In June 1963, the station passed close to the mysterious planet, but as communication was lost, no one ever found out what it saw there.



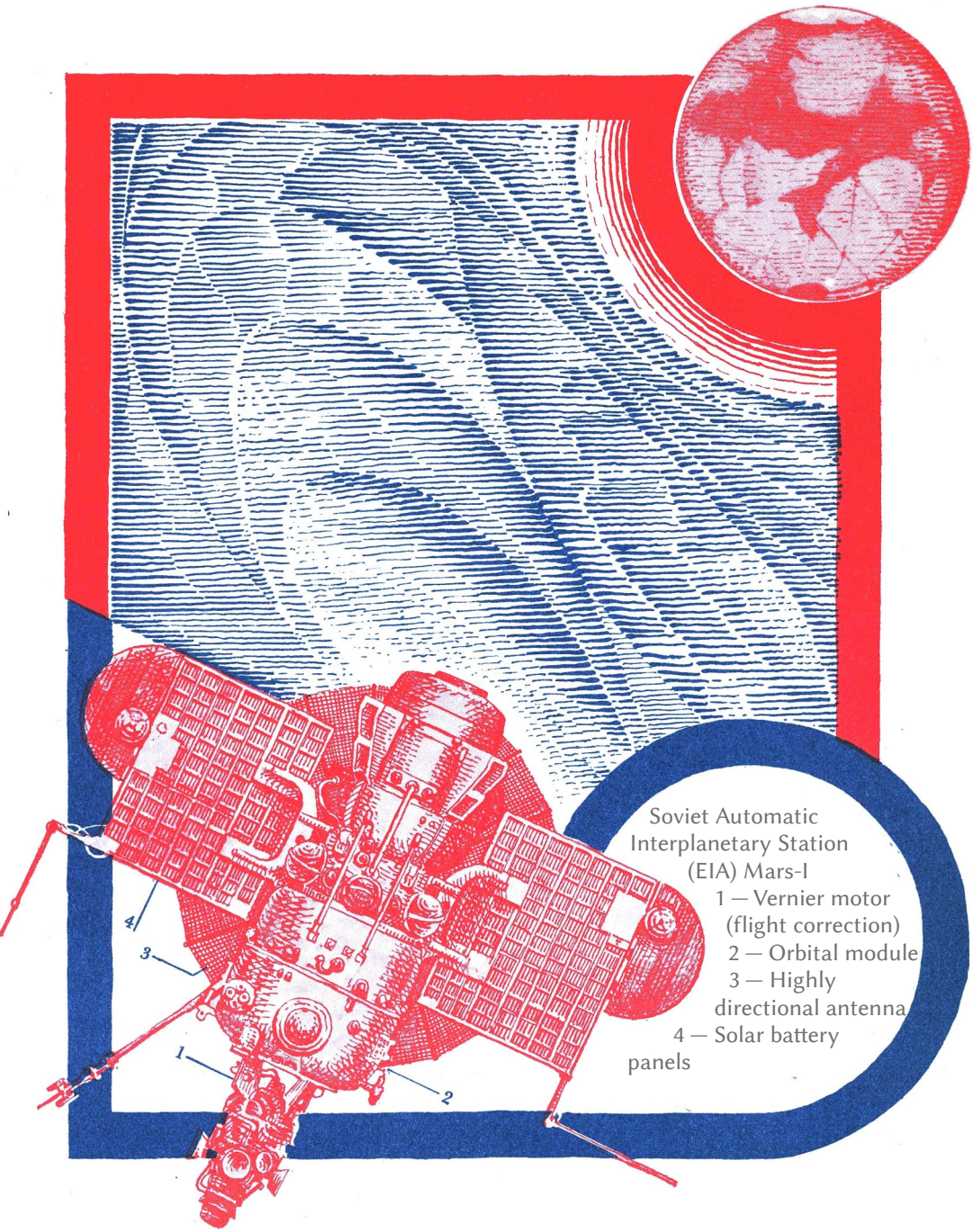
Mars-1 can't stop. It's doomed to drift in space forever, sometimes close to Earth's orbit, other times near Mars'. Maybe one day, many years from now, it will come close to Earth again. And those who see that bright star in the night sky will pay tribute to the steel hero who "gave its life for science."

During those five months, *Mars-1* managed to send lots of valuable reports about space.

But the best part was that many experiments were done and lots of gadgets were tested during that trip. This first adventure made building and launching new stations much easier later on.

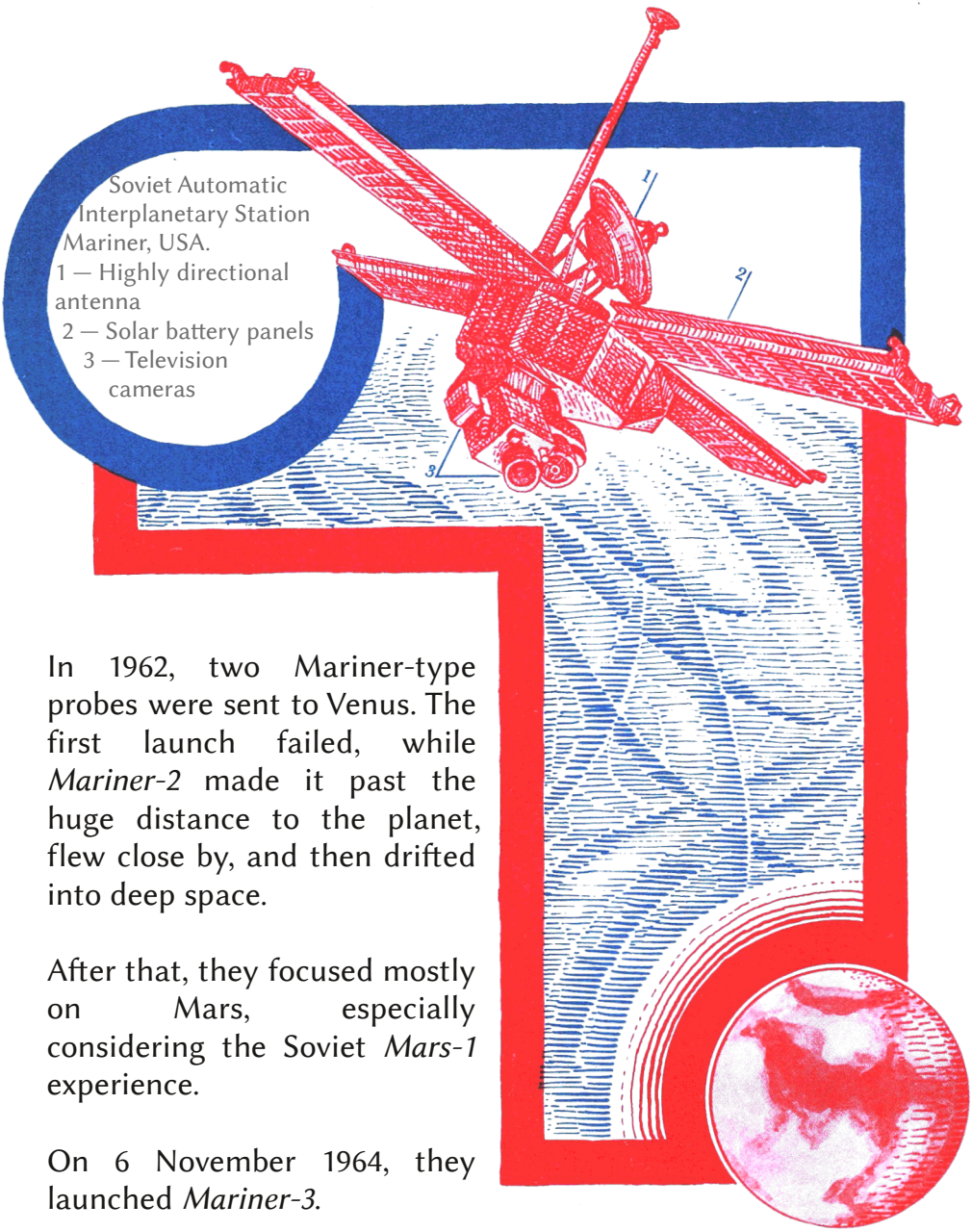
The USA also began launching automatic interplanetary stations of the Mariner series to fly to Venus, Mars, and Mercury.

Rocket that carried Mars-I to Martian orbit



Soviet Automatic Interplanetary Station (EIA) Mars-I

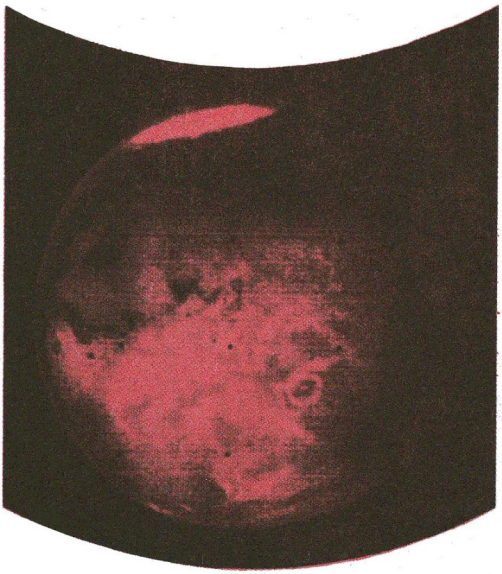
1 — Vernier motor (flight correction)
2 — Orbital module
3 — Highly directional antenna
4 — Solar battery panels



In 1962, two Mariner-type probes were sent to Venus. The first launch failed, while *Mariner-2* made it past the huge distance to the planet, flew close by, and then drifted into deep space.

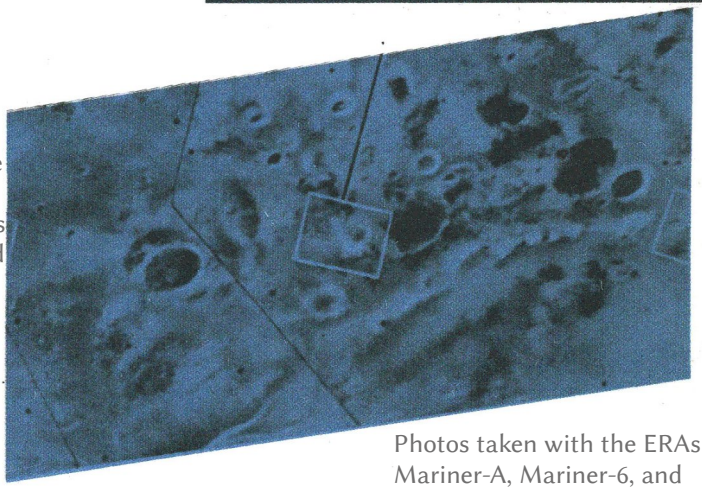
After that, they focused mostly on Mars, especially considering the Soviet *Mars-1* experience.

On 6 November 1964, they launched *Mariner-3*.



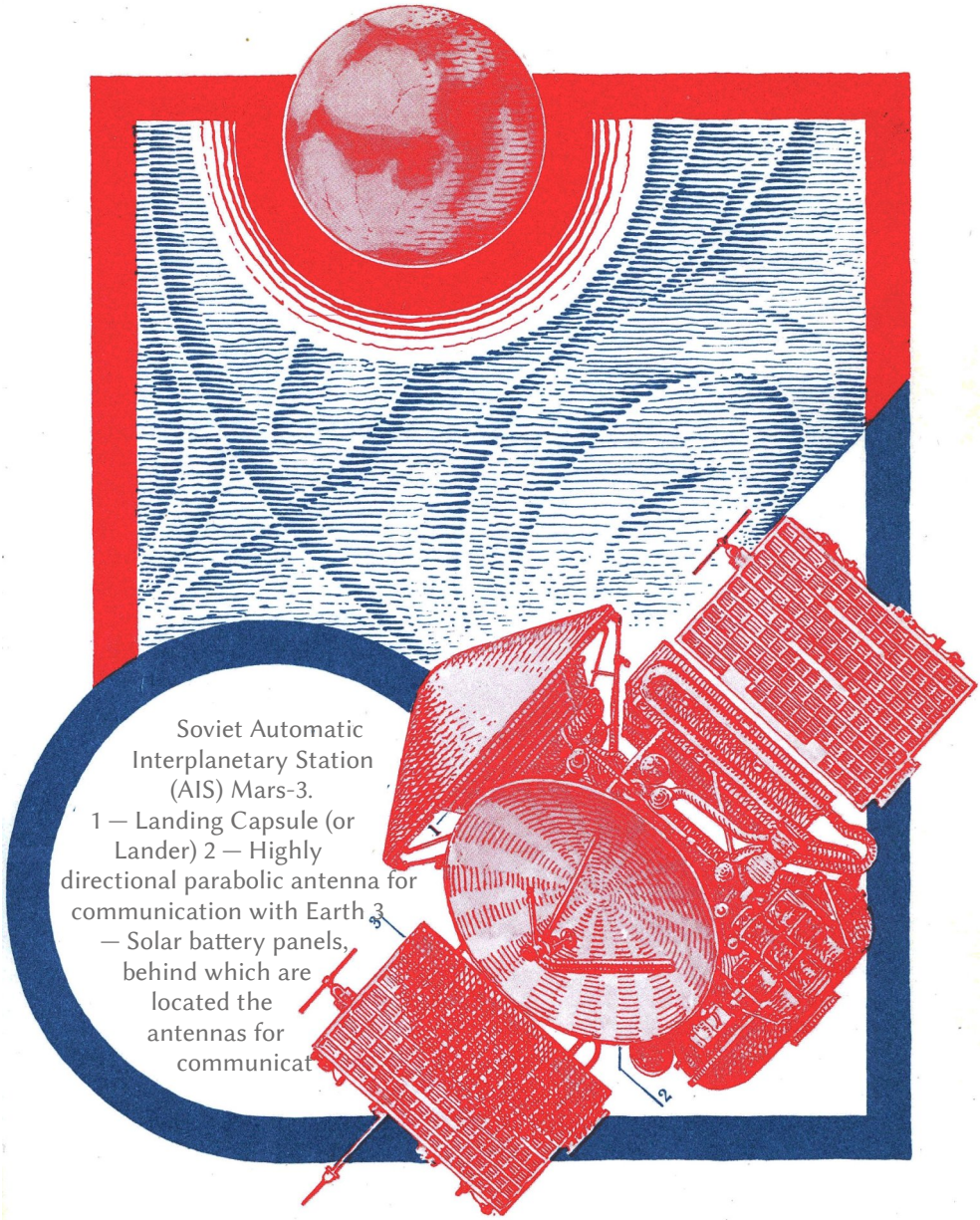
Mars seen from about 500,000 kilometres away.

Photos taken by the ERAs up close showed that the Martian surface is dotted with round depressions that look like lunar craters.



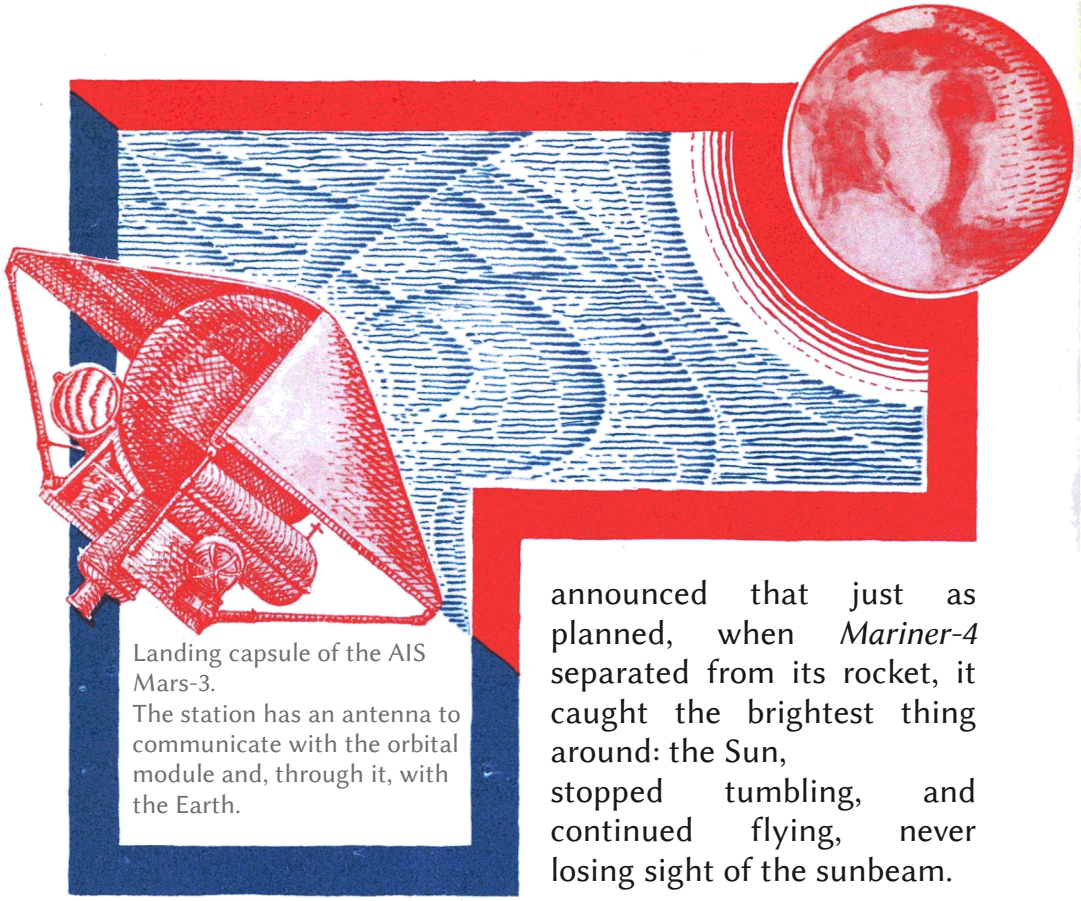
The Martian surface: a part of the polar ice cap.

Photos taken with the ERAs Mariner-A, Mariner-6, and Mariner-7.


Soviet Automatic Interplanetary Station (AIS) Mars-3.
1 — Landing Capsule (or Lander) 2 — Highly directional parabolic antenna for communication with Earth 3 — Solar battery panels, behind which are located the antennas for communicat

But no luck. A little after launch, the guidance system broke, cutting off communication.

On 27 November, *Mariner-4* was launched. The Americans



Landing capsule of the AIS Mars-3.
The station has an antenna to communicate with the orbital module and, through it, with the Earth.

announced that just as planned, when *Mariner-4* separated from its rocket, it caught the brightest thing around: the Sun, stopped tumbling, and continued flying, never losing sight of the sunbeam.

Its second "eye" was supposed to catch the bright star Canopus. There are many bright stars, and the station made mistakes several times. First, it caught the light of Aldebaran. Earth replied that was an error.

The station turned again, caught Regulus. Another mistake. Around the world, telegrams said: *"Mariner is broken."*

On the fifth try, the station caught Canopus. Then it was ordered: "fire the engine." Correction was possible. *Mariner-4* flew for 229 days, that is seven and a half months. On 15 July 1965, it passed only 9,000 kilometres from Mars. Its onboard cameras focused directly on the "Red Planet."

From Earth, the order came to start photographing.

In the photographs taken, it was appreciated that Mars did not appear to be a "living planet," like Earth. On the contrary, it strongly resembled the Moon with the same "ring-mountains" and hollows like the lunar craters.

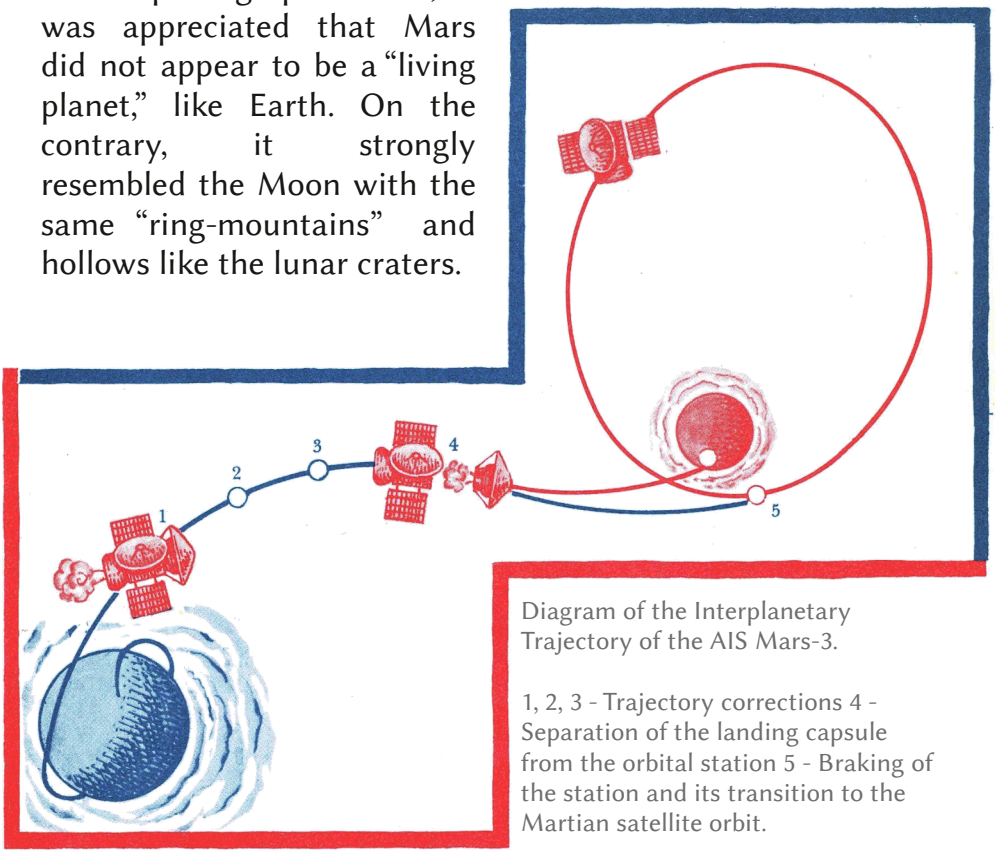


Diagram of the Interplanetary Trajectory of the AIS Mars-3.

1, 2, 3 - Trajectory corrections 4 - Separation of the landing capsule from the orbital station 5 - Braking of the station and its transition to the Martian satellite orbit.

Scientists were astonished. Those who believed there was life on Mars were discouraged.

But the discouragement was short-lived. They reasoned sensibly: it was necessary to continue launching probes (stations) to photograph Mars more closely and achieve better photographic quality.

The year of the famous Mars "opposition" arrived.

On May 19, 1971, our *Mars-2* ascended to the Cosmos, and on May 28, it was followed by *Mars-3*. On May 31, *Mariner-9* was launched. Three probes flew toward Mars at the same time.

Everything was unfolding perfectly. The enigmatic planet was already very close, and suddenly, a fierce *dust storm* broke out there. Hurricane-force winds lifted clouds of dry sand and dust into the air. A murky film covered the entire planet, through which nothing could be seen.

Dust storms had been observed on Mars before. But one of such magnitude, which completely obstructed vision, had not been seen for a long time. What a shame! So many efforts made in vain! Flying for more than half a year only to find the target enveloped by a sand and dust storm!

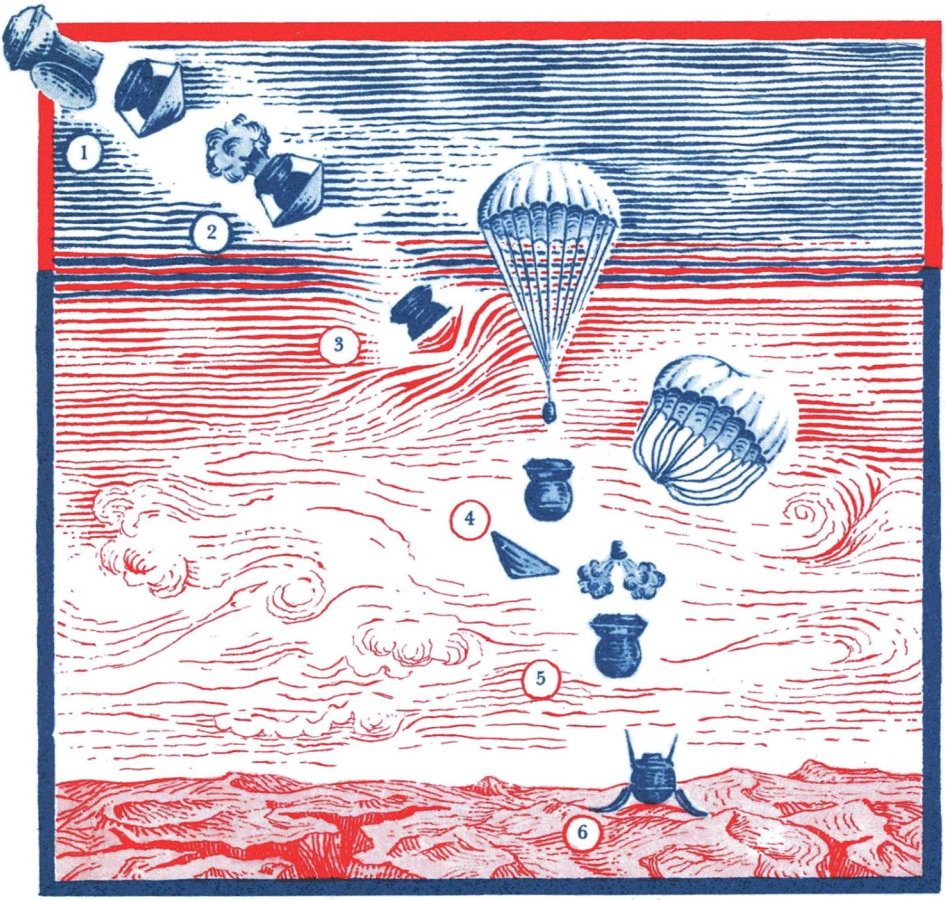
But they had to persist. It was absurd to return without completing the program.

The *Mariner-9* traveled along a shorter trajectory and reached the goal before all others. On November 13 (1971), it entered Mars' gravitational field, slowed its movement a little, and began to orbit around it.

On November 27 (1971), *Mars-2* arrived. As it was approaching Mars, a capsule detached from it and descended directly, crossed the dusty atmosphere, and "landed" on the planet's hard surface. The capsule carried a plaque with the Coat of Arms of the Soviet Union.

This is a date to remember. On this day, November 27, 1971, the first contact of man with Mars occurred!

The Mars-2 station, decreasing its velocity, became a satellite of the planet.



Descent Scheme of the Mars-3 (Marte-S) Landing Capsule.

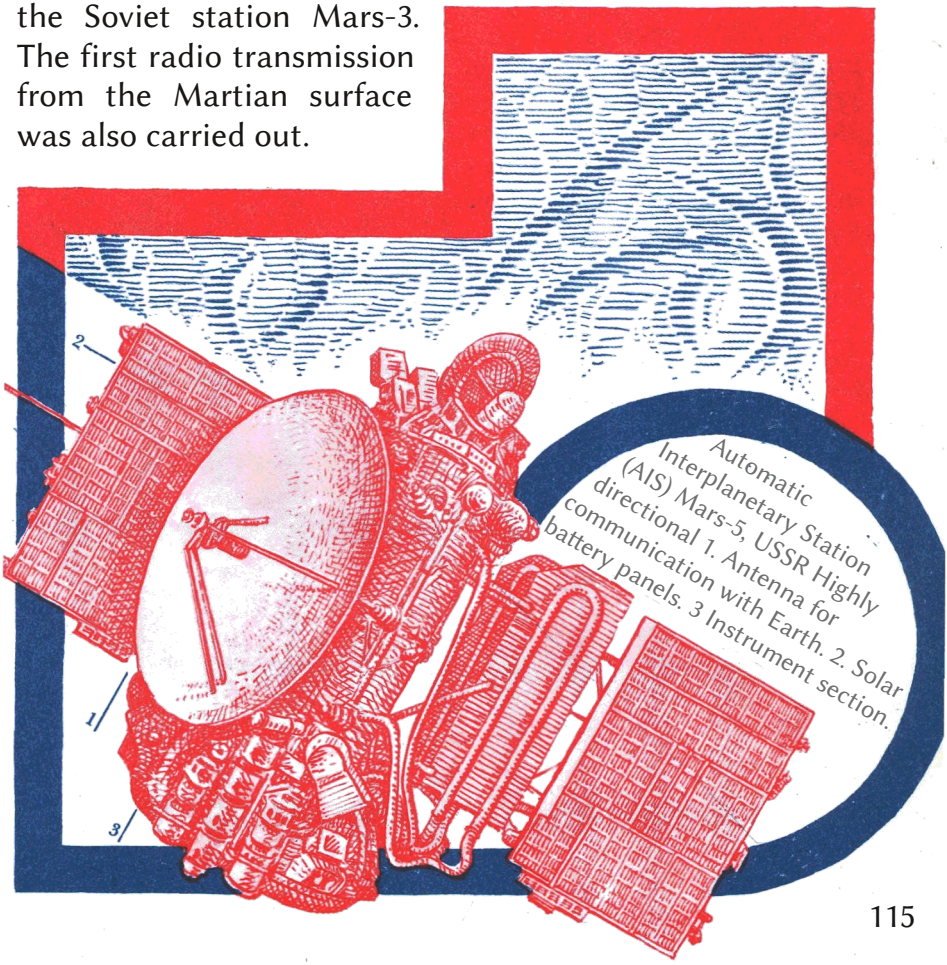
1. Separation of the landing capsule. 2. Firing of the landing capsule's engine (for braking). 3. Aerodynamic braking. 4. Parachute descent. 5. Firing of the soft-landing engine and retraction of the parachute. 6. The landing capsule on the Martian surface in operational state.

Mars-3 reached its destination on December 2 (1971). It also had to begin executing its program right in the middle of the

storm.

When it approached the planet, a "descent apparatus" detached from it. This immediately turned and connected the braking engines. The speed decreased, and the apparatus began to descend, just like an airplane coming in to land. Contact with the atmosphere reduced its speed even further. The parachute opened. With 20 meters remaining, the braking engines were connected again, and the apparatus descended softly onto the surface.

The first soft landing on Mars was achieved by the module of the Soviet station Mars-3. The first radio transmission from the Martian surface was also carried out.



Automatic Interplanetary Station (AIS) Mars-5, USSR Highly directional 1. Antenna for communication with Earth. 2. Solar battery panels. 3 Instrument section.

The photographs obtained from the probes provided new surprises to scientists. In addition to the already known craters, they clearly saw mountain ranges, deep gorges, and sand dunes, volcanoes, and hardened lava flows. All this made Mars resemble the Moon less.

Interest in Mars increased again.

In 1973, the next "opposition" of the two planets took place. New explorers were sent. On July 21 and 25, and August 5 and 9, the Soviet stations *Mars-4, Mars-5, Mars-6*, and *Mars-7* departed.

All of them successfully completed the journey of hundreds of millions of kilometers and provided scientists with new information about the planet.

On March 12, *Mars-6* transmitted important data about the Martian atmosphere.

Mars-5, circling the planet, studied it in detail and photographed its surface, area by area. Many high-quality photographs were obtained.

Let's take stock and see what twelve years of exploration of the "red planet" have given us.

WHAT DID THE SPACE PROBES SEE FROM THEIR ORBIT?

Let's look for maps of Mars, the old ones and the current ones. What's new? What is this planet like now, after the launch of the *Mars* and *Mariner* probes?

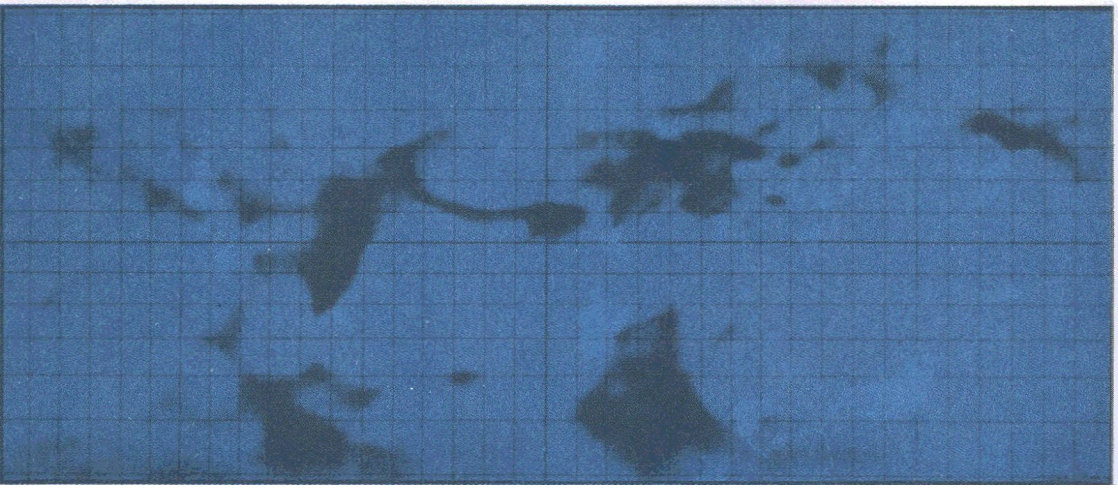
The old map only represents what is seen from Earth through the telescope: light and dark spots, that is, "continents," "seas," and "canals." The current one contains what the apparatuses saw: the relief, in other words, its entire surface: craters, mountain ranges, gorges, plains.

With binoculars, we can observe that on the Moon, the dark "seas" are plains, and the light "continents" are mountainous regions, and that it is full of craters.

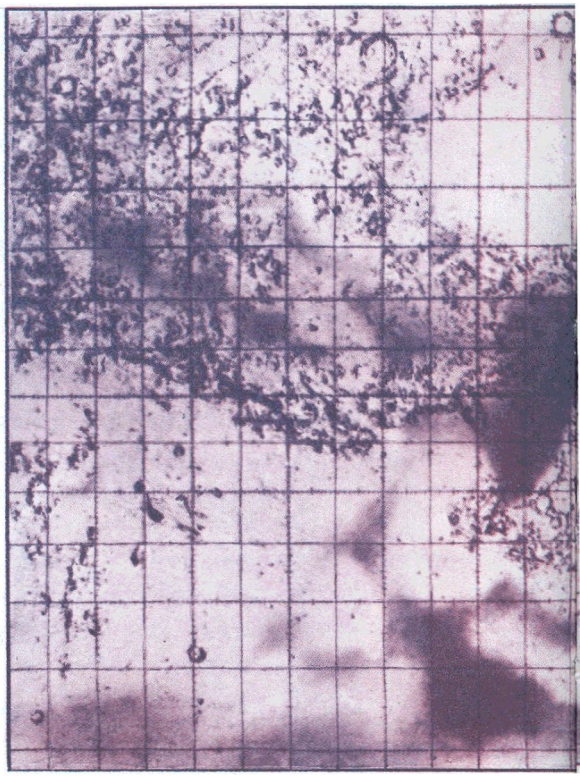
Scientists explained all this a long time ago. At one time, large meteorites "hit" the Moon everywhere. The craters are just the marks of those impacts. The entire Moon was then "continent." Furthermore, hot lava erupted from its depths, flooding large areas and covering the peaks of many mountains. The lava hardened and smooth, dark plains were formed... These are the lunar "seas."

Many thought they would find something similar on Mars, moreover, they desired it. They dreamed that the "seas" would be humid depressions, where life might nestle, as in our fertile valleys. And that the "continents" would be arid and desert-like plateaus.

When scientists received the new map of Mars, they compared it with the old one. They expected the mountains to coincide with the light "continents" and the plains with the dark "seas."

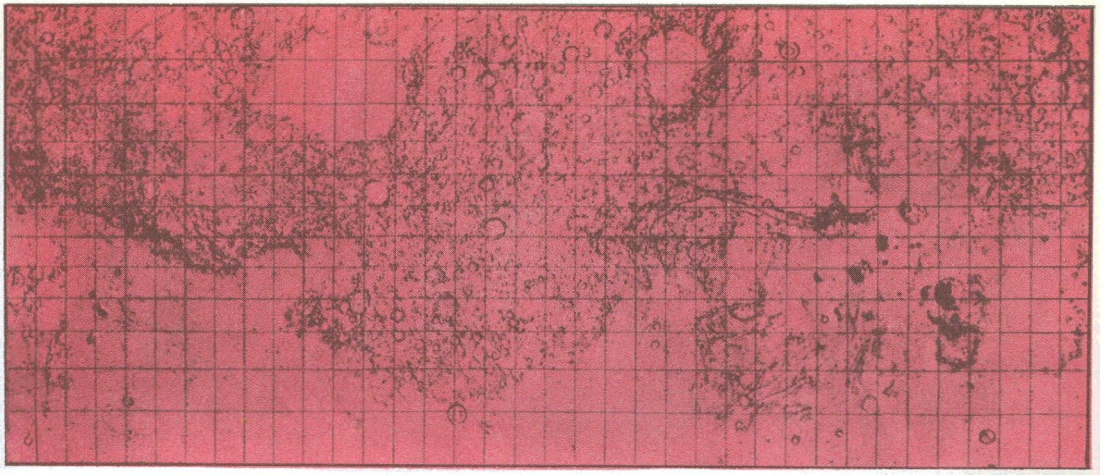


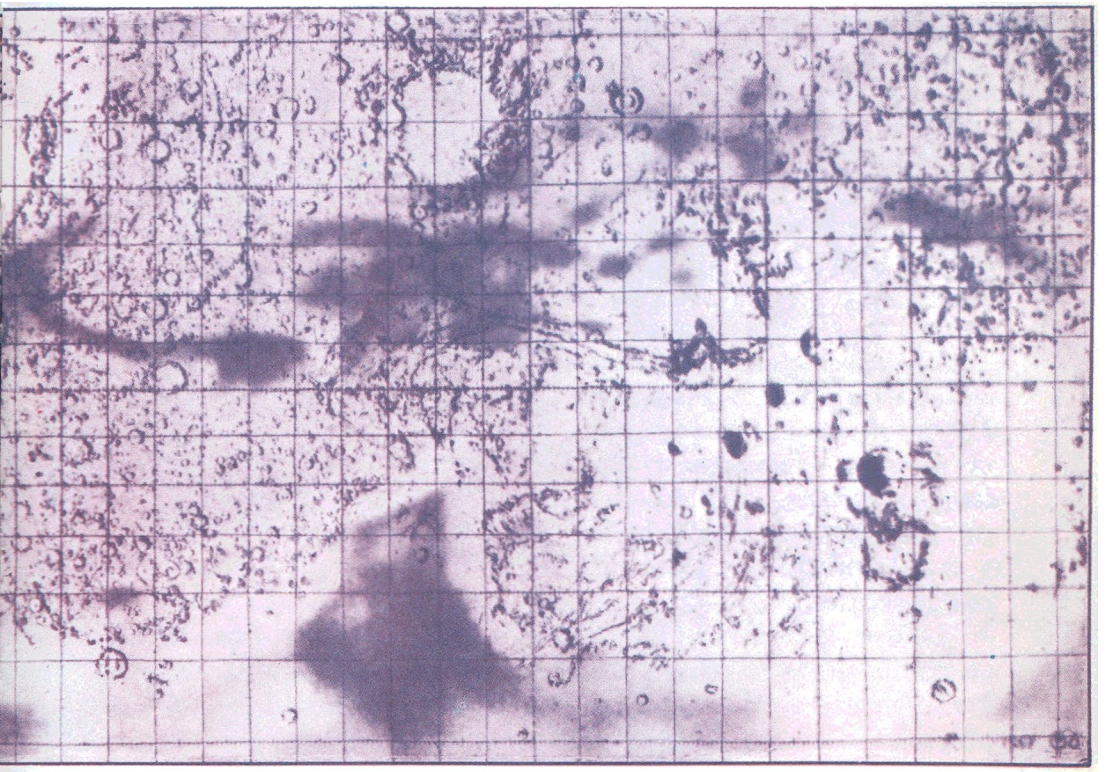
Top: Telescopic Observations from Earth. Map of the dark spots or "seas" of Mars.
Top Right: Photos from Automated Probes Map of the Martian relief (the actual surface features).
Bottom: Superimposed Maps
The image produced by overlapping the two maps.

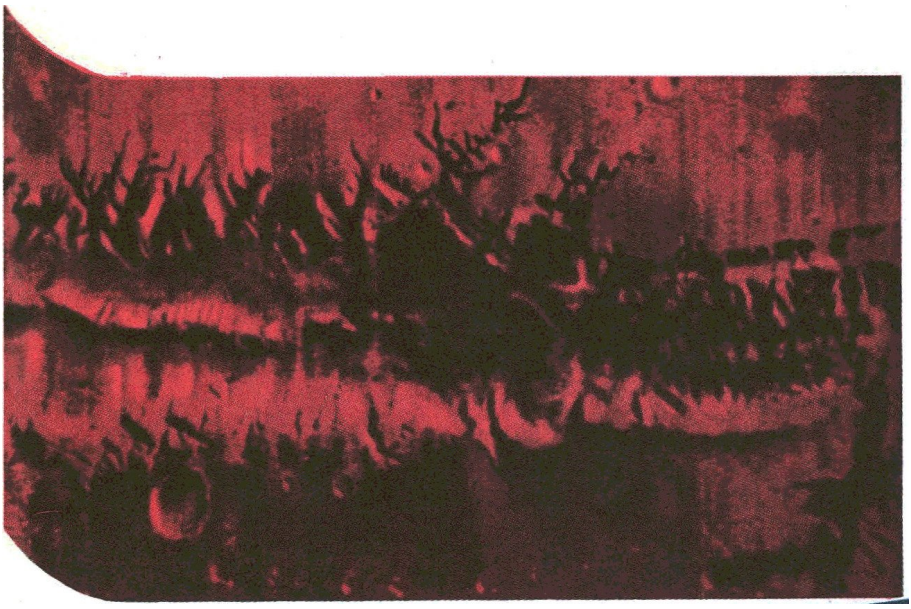


What they saw was something strange: the maps had nothing in common. The “seas” and “continents” of the old map and the mountains and plains of the current one had nothing to do with each other.

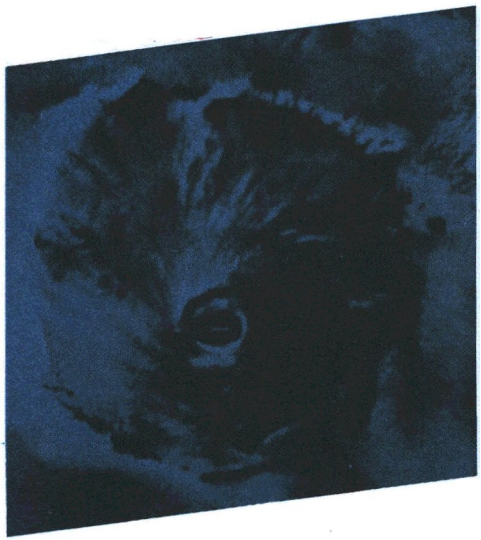
But if we observe the map more closely, we see that the Martian “seas,” unlike







The largest canyon on Mars, called Valles Marineris (Mariner Valley): It is 5 thousand kilometers long, 200 km wide, and 6 kilometers deep.



Olympus Mons: The largest dormant volcano of the Martians. It has a height of more than 25 km; Diameter at the base, 500 km; Diameter of the crater, 65 km. Photos from the AIS Mariner-9 (Automatic Interplanetary Station Mariner-9).

those on the Moon, "prefer" mountainous regions.

Almost all of them are distributed where there were craters and peaks. But there are exceptions: the *Mare Acidalium* is located on a plain, and the darkest spot on Mars, the *Syrtis Major*, is almost smooth.

The "continents" appear equally in the plains and the

mountains. *Hellas* and *Amazonis* are plains. *Eden* and *Aeria* are mountainous regions.

In some places, as if on purpose to mock us, the map contours coincide. For example, the round, clear spot *Hellas* stands out well on both maps in the same location. Only before, we were certain it was a mountainous island, rising proudly between the flat "seas" or depressions that surrounded it. But it turned out to be the reverse: *Hellas* is a basin with a flat bottom located between high mountains.

Let's clarify what has happened.

Let's compare Martian craters with lunar ones. On the Moon, these look like funnels formed by the explosion of projectiles. Their edges are raised, sharp, and steep. This is explained because the craters are marks of heavy impacts. Martian craters are marks of the same type, but they are flattened and "smoothed out." Why?

The Moon has no atmosphere, and its craters remain unchanged for hundreds of millions of years.

Mars does have an atmosphere. Very strong winds blow there, lifting sand and dust and carrying them from one place to another across the entire planet.

Imagine how all these forces can act upon the planet.

The strong sandstorms sweep the ground with enormous velocity. They scrape the rocks, wear down the surface, cut off all the protruding parts of the mountains, trim their vertices, and round off their edges. In this way, they gradually smooth out the face of the planet.

For this reason, Martian craters have almost *no raised edges.*

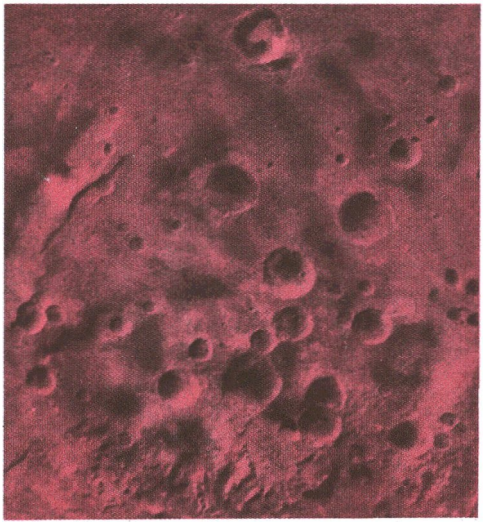
The strong winds, working like files, saw everything in their path, producing more and more dust. Keep in mind that these winds have been blowing on Mars for hundreds of millions of years! It is difficult to imagine how much dust and sand has accumulated during all this time! And where does

In the top photo, a lunar crater. Its rim is well preserved, steep, and minimally eroded.

Compare a Martian crater in the bottom photo, obtained by the Soviet AIS *Mars-5,* with the lunar one. As a result of the constant effect of the atmosphere on it, its edges are barely visible. It is eroded, erased, and sunk in the sand.

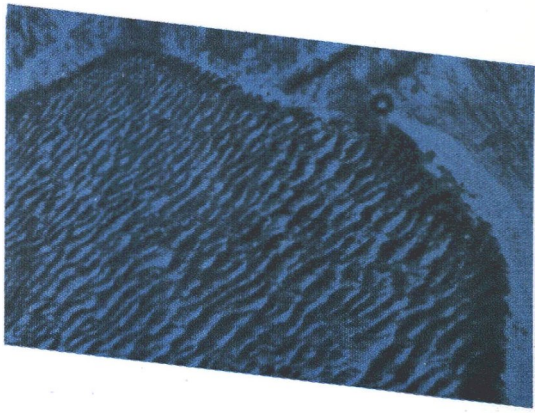
all this end up?

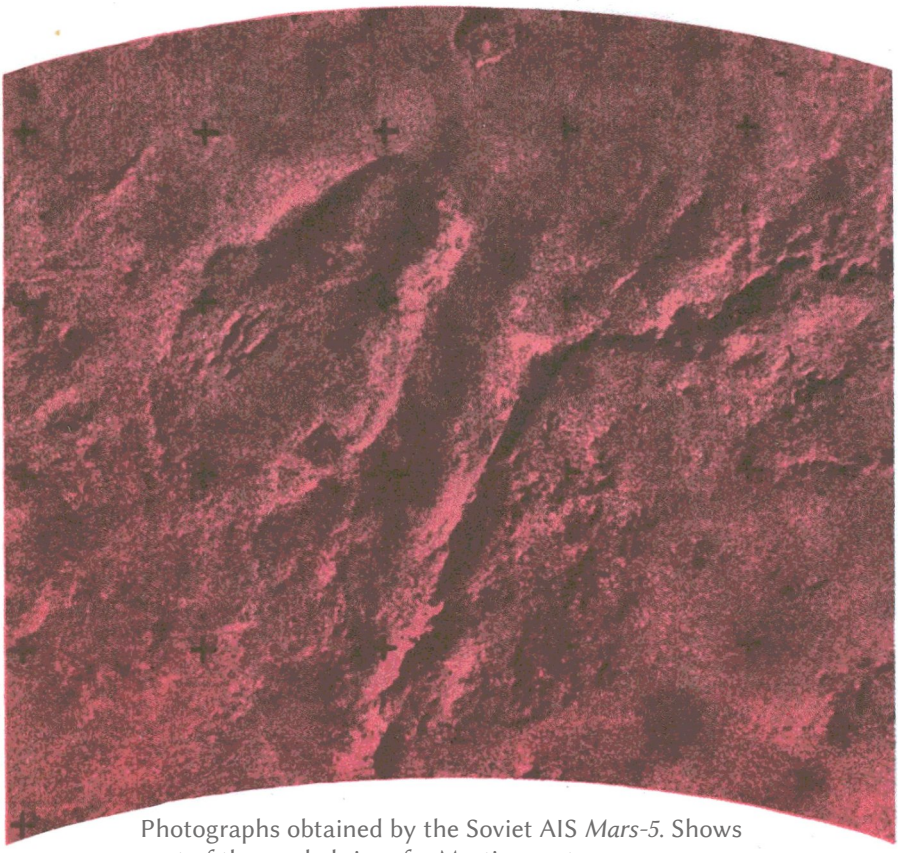
Generally, the winds transport sand and dust from the mountains toward the depressions. Entire countries could lie there, beneath mountains of sand.



On Mars, as on the Moon, there must be dark seas of lava. But they are most likely covered by a thick layer of sand and dust. In general, the entire surface of this planet is "decorated" with layers of sand and dust, and not, like the Moon, with dark patches of hardened lava.

The photograph obtained by the Soviet AIS *Mars-5* (referred to as Marte-S in the previous text) shows craters with eroded edges. In the upper part of the image, some craters are almost flush with the surrounding plain. The photo captures about 1,000 kilometers vertically. The second photograph, obtained by the AIS *Mariner-9*, shows the flat bottom of a Martian crater covered with sand in folds and dunes that cast their respective shadows. This is why the sand appears darker than the rocks around it. The dunes are separated from one another by about one kilometer.





Photographs obtained by the Soviet AIS *Mars-5*. Shows part of the eroded rim of a Martian crater.

Sand and dust appear light only when distributed in smooth layers. Conversely, if they pile up and wrinkle into folds, they look dark. Remember our beaches. Where the sand has been stepped on, it looks darker because shadows form in the hollows of the footprints.

If we look at a photographed Martian plain where sand accumulates in dunes, we will notice that it looks darker than the rocks surrounding it.

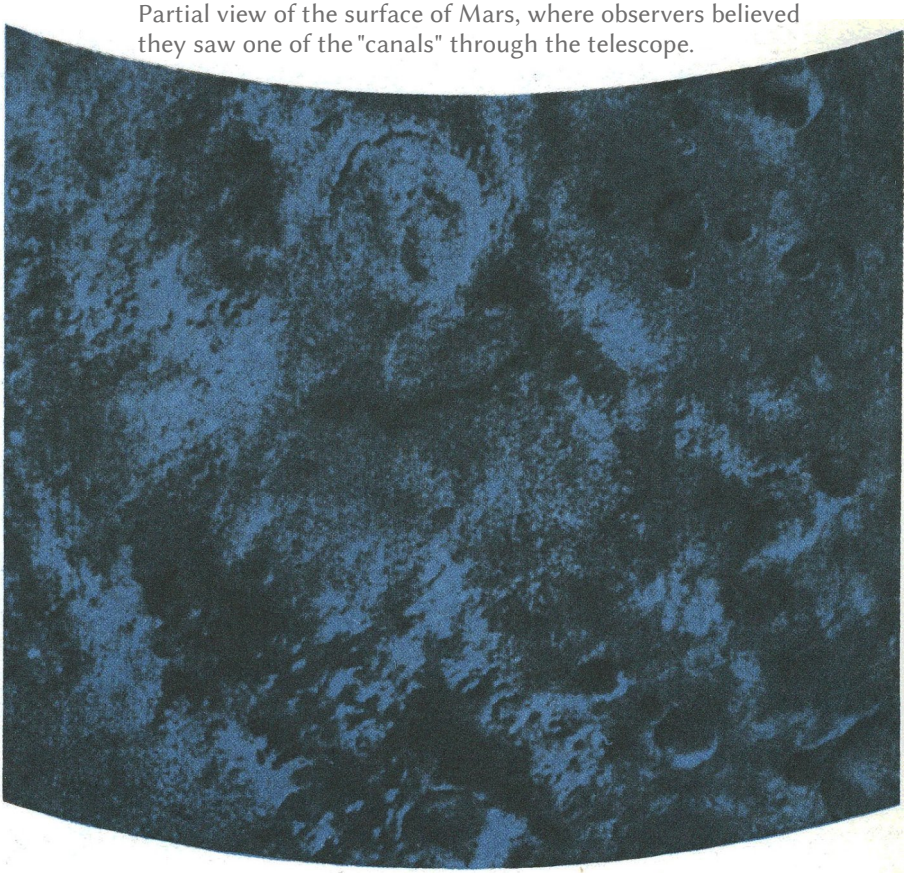
The Martian winds can completely change the appearance of

the light and dark patches, covering some regions with sand and dust and leaving others exposed.

Generally, the winds do not blow the same way at different times of the year. It is probable that because of this, the "seas" darken in spring and lighten in autumn.

It may also happen that the winds raise dust clouds. Perhaps we see dark mountains through these transparent clouds and think that the "seas" have brightened.

As you can see, many of the phenomena that occur on Mars



Partial view of the surface of Mars, where observers believed they saw one of the "canals" through the telescope.

can be explained without invoking dense forests. So, it is all due to the winds and the dust.

We said that the patches on Mars not only darken in spring but also acquire a greenish color. It was believed that this "re-greening" was the awakening of life, the blossoming of vegetation. *How can this be explained now?*

Here, apparently, there was a confusion from the beginning. The light patches on Mars have a reddish tone, the same as the Martian sand. Do a test: place a red paper next to a grey one, and you will notice that the latter will look greenish. It is nothing more than an "optical illusion." Let's add, moreover, that everyone wanted those seas to be green. And in reality, they are grey.

And what about the famous "canals"? What did our automatic probes see in their place when they flew very close to the planet?

They saw nothing special. In the place of the "canals," there was the same as everywhere else. No straight lines were visible, nor were there trenches or embankments, or patches stretched out in rows. Sand, craters, and mountains are distributed across the surface in complete disorder.

But the "canals" could not have been invented without any basis. Yes, they did exist, though very few.

Looking at the map again, we notice that in some places there are some fine chains of dark craters instead of "canals." From afar, they look like a line, particularly to the eyes of someone who insists on seeing a "canal" in that spot.

In some areas, large ravines or deep chasms were observed. These actually look like dark, curved strips, and not straight ones. It is here that imagination intervenes, and the astronomers, without realizing it, draw them on the maps as straight lines. Perhaps this was under the influence of Lowell, who asserted that the "canals" were straight.

Men believed they saw these "canals" at the boundaries between a region of high mountains and the plains. In reality, from Earth, the mountain slopes look darker than any plateau or plain at their base. Perhaps this is because the dust slides off the slopes and doesn't adhere, or because the gorges between the mountains are nothing more than shadows.

Today, for almost all scientists, the "canals" were a product of human imagination.

Seeing Martians is a very nice dream. And we wanted to see those "canals" so much that we connected dots to get lines, straightened out the crooked strips, and drew those barely noticeable shadows darker than necessary. That is, we mistook our desires for reality.

We were very saddened when we saw the photographs taken by the Soviet and North American interplanetary probes. In the beginning, we had beautiful dreams of Martians and harbored the hope that the fantasists were right and that perhaps one day we could "land" our cosmic ships in a luxurious Martian spaceport. We were already imagining the pompous welcome.

What the automatic probes showed from orbit was a very different picture. It's a sad scene, without any sign of life, even plant life.

Scientists also clarified that Mars' polar caps were not snow or frozen water. They were frozen carbonic acid or “dry ice,” the same substance used here on Earth in refrigerators.

Does this mean that there isn't even water on Mars?

What to do? Is this the end of the dream? Should we forget about this planet and lose interest in it?

In the history of Mars, it happened as in good adventure books, where the hero who is about to succumb is saved at the critical moment by a friend who appears at the right time.

Our spirits were lifted by great news. According to the photographs, something more interesting than the “canals” of the North American astronomer Lowell was found on Mars.

Signs of water were discovered!

WATER!

Look at these photographs! Dry riverbeds are observed on Mars! The sandy hurricanes have not yet managed to destroy or fill them with sand. That means the hurricanes passed through here a short time ago.

That means that if there was water, there could also have been life!

We ask ourselves: where could so much water have sprung up on Mars all at once?

Let's think and remember: what is the origin of the water on planets?

A young planet is formed of concentrated cosmic dust and its surface is always dry. But, in its interior, it contains a lot of "mixed-in" water. Later, this water gradually emerges onto the planet's surface. During volcanic eruptions, it springs forth in different places; in the form of a column of hot vapor, it rises to the sky and turns into clouds, which then precipitate as rain. The rainwater flows together into puddles, streams, and rivers that run toward the depressions. This is how seas and oceans have formed over millions of years.

Many volcanoes are still preserved on Earth. They are also observed on Mars; in the past, they were more numerous, and water gushed from the planet's depths in large quantities.

What happened to that water?

Since Mars is smaller than Earth, it attracts surrounding objects with less force and cannot retain a thick, dense

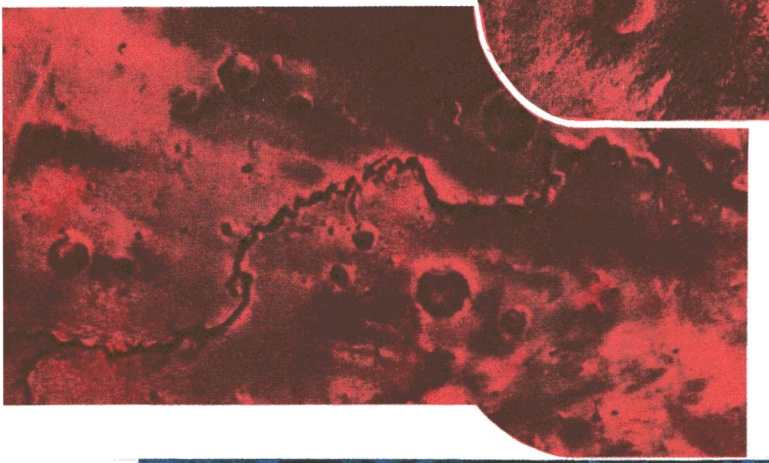
atmosphere around itself like ours. The rarefied atmosphere that covers the planet does not allow water to remain in a liquid state for long.

Photo from AIS *Mars-5* and *Mariner-9* (Photos):

Top Photo (Upper part): A sinuous and dark line is visible. It is the dried riverbed of the *Nirgai* river.

Center Panel: The riverbed of this river (Nirgai), between *Gurgas Aurorae* and *Ogygis Regio*.

Bottom: The dry bed of another Martian river, in the *Mare Cimmerium*.



Imagine what would happen if we put a plate of water on Mars. Due to the rarefied air, the water will boil immediately while remaining cold. After a short time, it will all boil and rise into the atmosphere as vapor.

If we pour the water from the plate onto the dry Martian sand, the sand will quickly absorb it before it can evaporate, and the water will penetrate the planet's soil where it will be preserved frozen.

The Martian soil, in general, is quite cold. Even on the hottest summer days, it only warms up to half a meter deep. The temperature at this depth is much lower than the freezing point. The water that reaches it turns into ice and never evaporates.

Such surfaces that remain frozen all year round are very common on Earth. For example, we find them in the north of the USSR. They are hard and dry like stone. But it is enough to heat them for them to melt, become soft and wet, and release water.

It is very probable that the mighty currents that carved the riverbeds we saw in the photographs were absorbed by the soil and converted into perpetual snow (permafrost).

Studying the photos of Mars carefully, researchers discovered new deposits of water.

It turned out that those polar caps of the planet, which melt in spring and grow again in winter, are composed of frozen carbonic acid and contain underneath them and near the poles other caps that do not melt in summer. These are smaller in size and are formed of frozen water—ordinary ice. The truth is

that it is not clean ice, as it contains a lot of sand and does not accumulate in a compact mass, but is intermixed with the soil. But the total thickness of these ice deposits, apparently, reaches up to a kilometer and more, and the quantity of water contained in them is immense.

In other words, so much ice is conserved on this planet—in its frozen soil and in the polar caps—that if it were to melt, Mars would be covered with lakes and seas, becoming "equal" to Earth.

And this great wealth, this valuable moisture, is guarded on Mars "under lock and key."

All the same, there is water on Mars, the same water that the proponents of the existence of life so eagerly desired. A great weight was lifted from them. There is no doubt: there is plenty of water on Mars. Scientists, and finally, everyone, are delighted with this planet and long to see it inhabited. New hypotheses emerged. Fantasy opened its wings again.

First and foremost, the attempt was made to explain how the Martians could utilize the water kept "under lock and key."

The following conclusion was reached: if the dried riverbeds on Mars are "fresh" and water ran through them "freely" recently, it can be assumed that this same water flowed as a liquid many times. That is to say, on the planet's surface, there was liquid water more than once, and for short periods, which, upon being absorbed, froze, cementing the soil and forming the polar caps, only to then melt again for brief periods and run through the riverbeds; and so, this process was repeated many times.

What could be the cause of this phenomenon?

In the depths of Mars, as in our planet, it is very hot. There are parts where the heat is so intense that it melts rocks. Foci of a scalding, liquid "mash" form: this is the magma. It tries to erupt, moving the blocks of the Martian crust and penetrating the fissures; it makes its way upward, toward the planet's surface. Sometimes, it emerges through a volcano's crater. And in the form of incandescent and luminous lava, it spills out into the surroundings.

This magma, as it rises, heats the frozen ground from below, and the lava that spills out heats it from above. Therefore, in the vicinity of the volcanoes, the frozen ground can temporarily melt. The wet mass "erupts," expelling hot vapor from within. An enormous torrent of muddy water runs rapidly down the slope, breaking rocks, moving hills, sweeping away sand dunes, and carving riverbeds.

Later, the torrent dries up. Part of the water returns to the soil, and part evaporates. Only the dry riverbed remains.

If living beings exist on Mars, we assume they could become active, taking advantage of those fortunate moments, and then fall dormant until they repeat... But it turns out that there are not many volcanoes on Mars, and they erupt infrequently. The "warm-ups" are not frequent, and the "irrigations" are brief. It is unlikely that a climatic regime of this type can guarantee the development of Martian life.

Another, more interesting, hypothesis suggested that perhaps the climatic changes on Mars are periodic and violent, due to its axis wobbling in various directions, causing the planet to stagger like a top. It is possible that the planet changes the

angle of inclination of its axis, the shape of its orbit, or its position in space.

Due to all these factors, from time to time, for some thousands or even tens of thousands of years, warm periods arrive. Almost all the "dry ice" evaporates, and the planet is covered for brief periods by a relatively dense atmosphere. The ice in the polar caps and the permafrost melt. Mars begins to resemble Earth: clouds appear in the sky, which then, transformed into renewing rains, irrigate valleys and mountains.

Streams whisper, and rivers flow mightily. True oceans and seas rock their waves in the wind. If the atmosphere is dense, the water no longer boils and, therefore, does not evaporate so quickly. That is, excellent conditions for the rebirth of life are created. Mars turns green again, and living beings awaken.

After a while, the cooling begins again, until the dry and icy period is re-established. Life ceases. Incidentally, the climate also changes on our planet, although not as violently as on Mars, but over the course of millennia. Glacial periods alternate with periods of temperate climate. Thus, the hypothesis about the Martian "Great Year" seems quite plausible.

According to this hypothesis, Martian life could awaken temporarily not in small, isolated pockets near volcanoes, but across the entire planet...

Let's see what comments were made about Mars after the Mars and Mariner flights.

It was definitively clarified that there were no developed forms

of life on Mars, neither large groupings of trees nor animals.

Nevertheless, water was discovered, which cheered the distressed dreamers and showed rigorous scientists that it was essential to continue the search for life on this planet.

The dreamers resigned themselves to the idea that the Martians were primitive, tiny plants and animals that live in the soil, in caves, in underground waters, and in the craters of volcanoes that retain heat.

The scientists accepted that only "Martian-microbes" could be found there. Microorganisms like the ones found everywhere on Earth.

Everyone was sure that the satellites, from their orbits, hundreds of kilometers away, having obtained all possible information, would no longer provide new data. Future exploration would have to be carried out on the very surface of Mars, for which it would be necessary to descend to the "debated" and surprising planet.

THE SEARCHES FOR LIFE ON MARS

Searching for life! The simplest thing would be to fly to Mars, wander through its expanses, climb the mountains, look under the little stones, stir the sand, and descend into the caves. Everything would be clear at once.

But Mars is too far away. Just because man was able to reach the Moon does not mean that he can immediately fly to Mars. It would be a much more complicated and dangerous journey. We are not yet prepared for such an undertaking.

Before flying to the Moon, man prepared for many years, exploring it with the most modern equipment, through which much valuable data was obtained, allowing for a detailed understanding of it. When man flew to the Moon, he already knew exactly what he would find there.

It would be madness to "enter the water without knowing where the crossing is" (i.e., rush into an unknown situation). That is why in the conquest of the Cosmos, automatic probes have always gone and will go ahead of man, marking the way for him, surveying and clarifying the most important things.

The same is true in the case of Mars.

It has been decided to get to know it better with the help of automatic probes; to receive the information they will transmit from there: what they will see, hear, smell, and assess, while we here, on our comfortable planet, Earth, without any risk, comfortably seated, will analyze the data they send us.

Automatic probes are more resilient than man and can be

launched onto the planet from a small altitude. They will fall and then, as if nothing happened, they will begin to function, transmitting invaluable information to us.

The probe does not catch a cold even if it freezes. Nor does it lose consciousness due to excessive heat. It can "sleep" during seven months of flight if there is nothing to do; and during this time, it is not necessary to feed it, give it water, or warm it. It does not need rest. If there are many tasks, the robot can work "without closing its eyes" even for a whole year.

And perhaps the most important thing is that the probe does not need to be recovered. Once its mission is complete, it will wait on Mars for the arrival of the Earthlings. The design that was used to manufacture it remains on Earth, and it can always be replaced.

Of course, abandoning machines that cost so much work is always a shame. However, a machine is not a man. We still do not know how to bring any probe back from Mars. Later, when we finally arrive there, we will collect all our probes, bring them back to Earth, and place them in a special museum. This will be the museum of the metallic heroes of science.

The soft-landing probes are already flying to Mars.

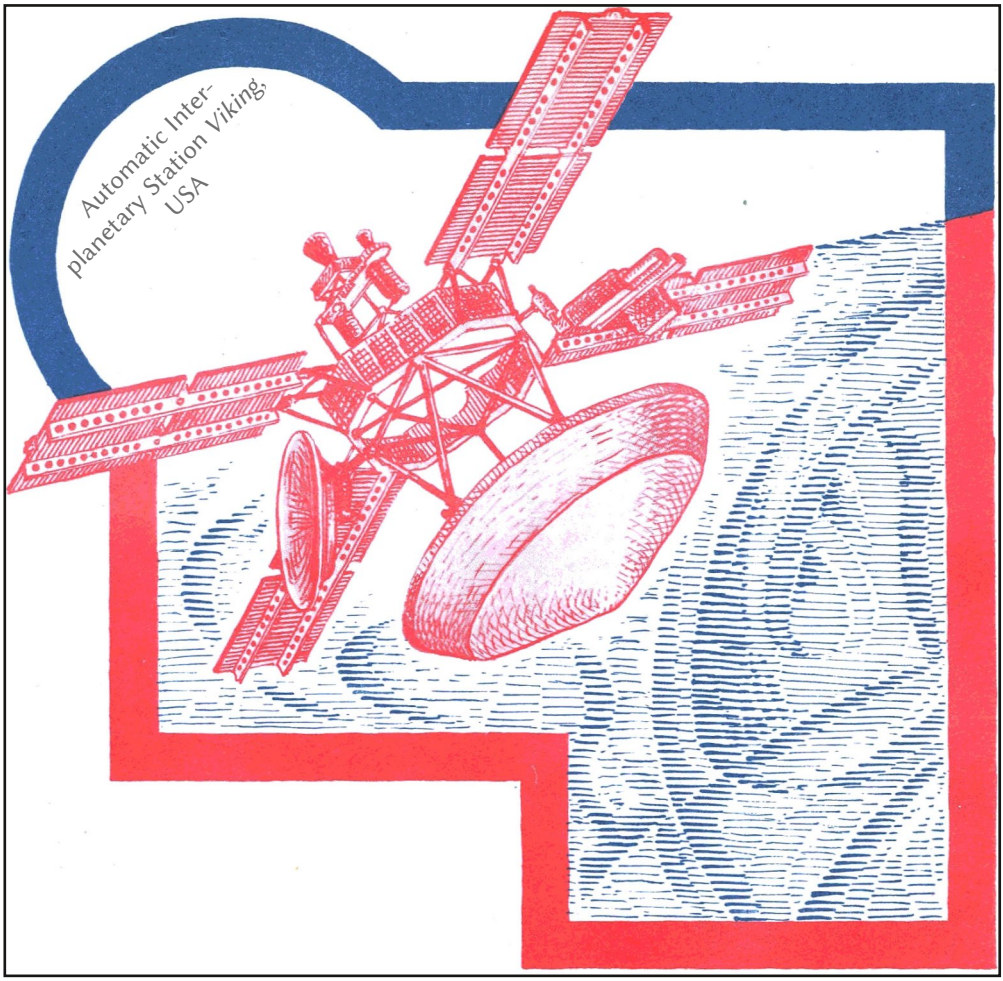
Remember that in December 1971, the Soviet *Mars-3* performed a soft landing on the Martian surface. The Americans manufactured their probes taking this landing into account, and in 1975 they launched theirs to Mars. These were extremely complicated and very interesting machines; we will describe them in more detail.

It was no accident that they called their machines *Vikings*. The

Vikings, originally from Scandinavia, were brave warriors and seafarers who, a thousand years ago, traveled to distant and unknown lands, discovering and conquering them.

The *Viking* flight was prepared for many years.

Special, "intelligent" and safe probes were invented, which could autonomously perform complicated analyses of the



Martian soil and take sharp, color photographs of their surroundings, millions of kilometers from Earth.

Before landing on the planet, they took photos of its entire surface from orbit to create a detailed map. Several suitable locations for the descent of the automatic probes were chosen —just in case. It was necessary to perfect rocket technology to such an extent that the launches of complex and expensive machines would be safe, and carried out without the fear that the rocket would get "lost" in the Cosmos or that the so-called module could not perform a soft landing at the planned point.

This is how, on July 20, 1976, *Viking-1* began the "landing" operation.

This module was divided into two parts: the descent craft and the orbital section, which remained orbiting to transmit radio communications from Earth to the planet and vice versa.

The crucial moment had arrived. The *Viking* descent module slowly separated from the orbital section and began to descend. At first, Mars' rarefied atmosphere did not impede its flight. But from approximately 250 kilometers, the air began to resist it, slowing it down with ever greater force. The probe flew with the front cone positioned as a shield so that the resisting torrent wouldn't destroy it.

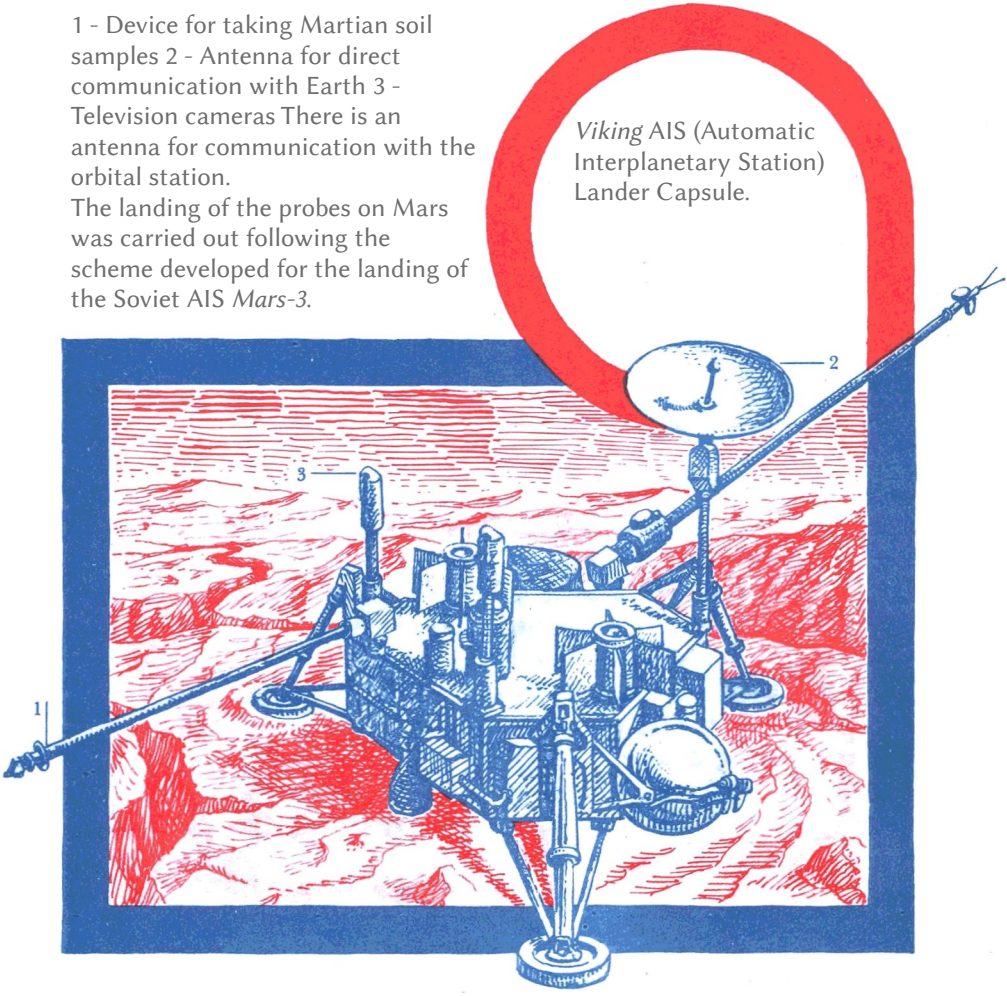
The speed decreased to 400 meters per second. This was only slightly faster than a passenger plane.

The height was 6 kilometers. The probe was already flying over the region chosen for descent. The parachute opened. It was large, about 16 meters in diameter. The speed decreased sharply, and the probe began to descend almost vertically and

slowly. At a height of one kilometer, the parachute separated; the wind carried it away.

Four rocket engines were started on the probe, with their nozzles pointed downward. Four roaring jets of flame aimed at the surface of Mars, checking the probe to descend more slowly. Now the speed was one meter per second! The hard ground was very close! Ten meters left!... Five meters... four... three!... The engines were shut down simultaneously so as not

1 - Device for taking Martian soil samples 2 - Antenna for direct communication with Earth 3 - Television cameras There is an antenna for communication with the orbital station.
The landing of the probes on Mars was carried out following the scheme developed for the landing of the Soviet AIS *Mars-3*.



to burn the landing site with the fire jets. The steel colossus, deprived of its last support, fell onto something soft. One leg sank into the soft sand. A cloud of dust rose, covering the descent module for a certain time. The dust cloud vanished.

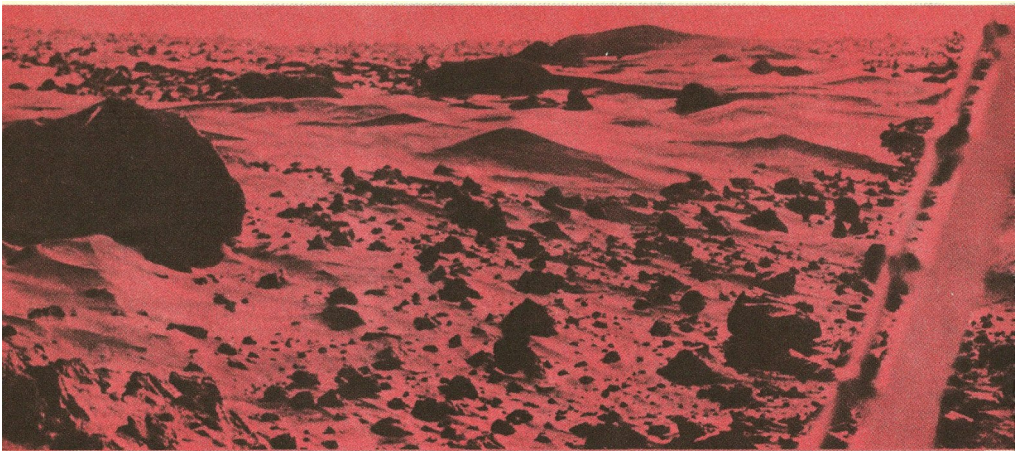
Absolute silence! The *Viking* was on Mars!

The work began immediately. First of all, the probe, with the help of its television cameras, captured the surrounding area and immediately transmitted the images, via the orbital section, to Earth. It took twenty minutes for the radio waves to travel hundreds of millions of kilometers and reach Earth. Here, they still did not know for sure if the probe had "landed"; anything could have happened, like hitting a rock and overturning, or falling into a crack and being damaged. The minutes of waiting were unbearable.

Finally, an image began to appear on the cosmic television screens.

An endless desert, with sand dunes piled up by the winds, similar to the snowdrifts that form on Earth in winter. And rocks, many rocks heaped up to the very horizon. The rocks, smoothed by the stinging blizzards, looked half-covered with sand, and were of different sizes. Not far away, a large boulder, three meters high, was visible. In the distance, protruding from the "waves" of sand like the back of a fabulous whale, was a stone mass that measured about one hundred meters. The horizon was not far. Apparently, the probe landed in the center of a small crater, and the captured hills were its edges.

The whole landscape was an unusual color. The sand was reddish, the sky pinkish, a little lighter toward the horizon and darker toward the zenith. The stones had a greenish hue.



Everything in this landscape looked so clear! You look and it seems as if you are standing on this immense stone plain, and you only need to lean down to touch the stones with your hand. But they are not nearby. Not even on Earth. They are there, on that reddish planet, which, without blinking, watches us from the starry sky at night.

But cosmic probes are not just "eyes" that man was able to place tens of millions of kilometers away. They are also man's skillful "hands" with which he could "touch" another world. And not only "touch" it, but also perform experiments on it. In fact, there were "mobile laboratories" of physics and chemistry equipped with everything necessary.

Viking-2 landed on Mars on September 4, 1976, thousands of kilometers from the first probe. This allowed for a comparison of the planet's nature in different regions.

Intense work began on Mars.

Viking-1 extended its long steel "hand" and took a handful of

Panorama of the Martian surface, transmitted by the *Viking-1* Lander capsule

Martian soil. At the same time, it showed us the trench left in the ground: its edges did not crumble. The soil was like moist sand, despite the fact that we knew it was dry. This was the first enigma.

The probe, after taking a handful of soil, began to analyze it and reported the results to Earth. All the elements composing it were those known on our planet. Only the proportion varied; it had a large amount of iron, though oxidized. That is why the Martian sand looks reddish, and that is how we see Mars from Earth.

The station transmitted weather reports. The temperature was then minus 30° Celsius below zero. At night, it dropped to 80°. Winds were moderate. But, judging by the sand hills, the hurricanes there are stronger than ours.

However, the main task of both stations was to answer the question: *"Is there life on Mars?"*

Discovering life on Mars! It is easy to say!

Of course, had the *Viking* landed in a Martian kingdom where friendly "little men" solemnly received it with many flowers and an orchestra, the problem would have been solved immediately.

It would be easy to "discover life" in a lush forest, where the buzzing of strange insects is heard, where marvelous birds flutter and fantastic animals run. With the first photograph, we would see everything, the recorder would capture the sounds, and special probes would even capture the smells.

It would be more difficult to discover life in a desert, where the inhabitants of that planet, the "Martians," could be, for example, tiny clusters of greenish mold on brown stones, or small "turtles" hidden in the sand, the same color as the sand itself.

However, modern probes are capable of discovering these types of life, by taking color photographs of the environment and transmitting them to Earth. The color green is the color of life, so any small spot of that color would catch our attention. Observing the surroundings, the station's television cameras would stop from time to time to take several shots of the same landscape at intervals. By comparing them, it would be possible to establish whether any change occurred in the time the photographs were taken. If, for example, a spot was there and then disappeared, it would mean that something alive, capable of "escaping," was at that point.

The scientists understood that this type of life could not exist on Mars, and that it was most probable that the "Martians," if they exist, are simply microbes and not easily visible "worms" or "insects" that can be photographed. Something similar to our bacteria, mold fungi, and other single-celled organisms. In

a word, it is most probable that the “Martians” are microorganisms. If so, then they are very small: a row of hundreds of bacteria takes up no more than a millimeter. How could an automatic probe discover them, one that is also millions of kilometers away from us? Can it tell us if there are those living, invisible knots on Mars that can only be seen through a microscope on Earth?

What to do? Send a microscope to Mars? It is possible, of course; it does not weigh much. But how would it be used there? How could a “clumsy” machine distinguish, through the microscope, a microbe from a dead particle? We know that microbes do not move. They adhere to any particle and remain motionless.

Despite everything, the probe sent instead of man can detect microorganisms in the soil of the distant planet. The matter is as follows: a single microbe can go unnoticed, but if there are billions of them, they will be noticed by their agitated mass activity. How would this be? Very simple. Microorganisms are living beings that grow and reproduce. To do this, they eat and digest food. They keep what is necessary for growth and expel what they do not use. For this reason, something always disappears around living microorganisms because it has been eaten, and something appears because it has been excreted. One microbe eats only a crumb while excreting another. But when there are many, what they eat or excrete is already substantial and is possible to register.

When milk sours, it is because bacteria are present that feed on it and break down the lactose it contains. As a result, lactic acid is the waste product of the bacteria's vital activity, which changes the taste of the milk.

When meat decomposes, bacteria are responsible for its putrefaction. By feeding on the meat itself, they leave behind the remnants of their "lunch," which are toxic to us, and hydrogen sulfide, which gives off an unpleasant odor.

If dough rises, it is because yeast fungi have been at work; they feed on flour and "exhale" carbon dioxide, which they no longer need, in the form of bubbles that inflate the dough.

We can say that microorganisms, however small they may be, and however much they hide, can always be discovered by their vital activity. This is one of the best ways to search for microorganisms in the Martian soil.

Precisely in this way did the scientists who created the Viking proceed.

According to the plans, in July 1976, the probe took a handful of reddish Martian soil, brought it inside, and poured it into three small containers.

The first experiment was directed from Earth. Upon giving the order, a small tap opened, from which a little nutritive liquid fell into one of the containers, moistening the arid handful of soil. For terrestrial bacteria, this liquid is a delicacy. It was thought that it would be the same for Martian bacteria, and that they would eagerly consume it, rapidly digesting it and expelling the "unnecessary" in the form of different gases, which the station was capable of detecting.

The result was that carbon dioxide began to emanate from the Martian soil, moistened with the "delicious" liquid. This happened with such intensity that the soil seemed to be full of hungry bacteria!

The probe immediately transmitted to Earth: *It smells! Gas is coming out! Lots of gas!*

On Earth, scientists were excited: they decided that they had finally found life on Mars!

The gas emanation began to decrease and then ceased completely. The researchers were disheartened.

Later, they analyzed the situation. The gas could be released without the presence of bacteria, simply as a product of chemical reactions between the soil and the liquid, unknown to us. It is true that in this case, the gas release should be more abrupt and would finish faster. Therefore, this was *not* a chemical reaction between the soil and the liquid.

If it were bacteria, they would work more calmly. The gas would be released more regularly, but more slowly. These were not bacteria.

What could it be, then?

Another experiment was performed to observe the opposite process: the *absorption of gas*.

Let's recall an example of this process on Earth. Our plants, in addition to water and the mineral mixtures contained in the soil, consume the carbon dioxide dissolved in the air. They can assimilate it only in the presence of light. This process is called photosynthesis and is also used by some terrestrial microorganisms; so we could expect the Martians to use it too.

On Mars, the probe injected a little carbon dioxide into the second container with the soil sample and turned on a

powerful lamp above it with light similar to sunlight. If there is someone in that soil, let them eat!

A few days passed. Then, the remnants of carbon dioxide were removed from the container. The vessel was heated until red-hot, until the handful of soil was burned. If there were microorganisms, they would die. And the carbon dioxide assimilated by them should pass into the air above the soil in the container.

And carbon dioxide came out! That means it was in the soil! That something attracted it, absorbed it, retained it! What could it have been? Perhaps microorganisms?

But the scientists were not rushing to celebrate.

The third experiment was conducted. The nutritive solution was poured into the container, but in a small quantity that did not manage to wet the soil, because it evaporated and only humidified the air. “Tasty, edible air” began to reach the soil. According to the researchers' calculations, if bacteria existed, they should assimilate this “tasty air” and expel gases like methane, hydrogen sulfide, ammonia, and others into the atmosphere. Gases soon began to escape from the soil. But mostly it was the gas they least expected: Oxygen! In a quantity that exceeded everything explainable.

Again, there was great enthusiasm, only to fall into confusion later. The release of oxygen began to cease after some time. It was thought that "they” might have swallowed it all. Another portion of the solution was injected into the container, but no more oxygen came out.

Scientists could not recall a single chemical reaction with

similar results. If this was the work of microorganisms, then why hadn't they "eaten" the second portion? Were they full? Did they die? Why did they die?

Once again, the scientists were facing the unknown.

They collected a new portion of soil, reheated it, and eliminated all possible living organisms. Then this "sterilized" soil was moistened with the nutritive solution. Since there was no one there to "assimilate" it, no gas should appear in the air above the soil.

But... carbon dioxide appeared!

How could the "waste" gas decompose and "emanate," knowing that there was no living organism in that soil?

It was unbelievable. Mars was mocking the researchers.

The module was ordered to lift a rock and collect a sample of the soil underneath it. It was explained that the Sun's ultraviolet rays can kill any living thing if it has no protection. Earth's dense atmosphere protects its inhabitants. On Mars, the atmosphere is one hundred and fifty times less dense, and these rays pass through it almost without weakening. Perhaps the Martian living beings, avoiding direct exposure to sunlight, stay sheltered somewhere?

Different experiments with soil samples taken from under rocks also gave doubtful results.

The most reliable answers, in the opinion of the scientists, should be obtained from the pyrolytic decomposition experiments, that is, the calcination (intense heating) of the

Martian soil.

The idea behind these experiments can be summarized with the following example. Imagine two spoons, each with a portion of sand. One portion of sand is clean, the other is "contaminated" with organic mixtures, that is, with substances of plant or animal origin. For example, with very small pieces of cotton thread or wool. These are not visible to the naked eye. How do you distinguish the clean sand from the contaminated one? Both portions are calcined. And the contaminated sand produces a "burning smell."

The body of any living being, whether plant, animal, or a simple microbe, unlike sand, is a combustible material. When calcined, it carbonizes, melts, burns, gives off smoke and a "burning smell" or gases, which any sensitive apparatus will immediately register.

Well, when the Martian soil was calcined, the probes did not detect a "burning smell."

This particularly saddened those who were counting on getting an affirmative answer this time to the question: is there, or is there not, life on Mars?

Comparing the results of all the experiments performed, it can be said that there is no definitive answer yet. We continue without progress: life on Mars is possible, but we have not managed to prove that it exists. The hope of this discovery is dwindling.

A North American scientist, one of the directors of the Viking flight, said that *"...these are unsettling and very contradictory data."* And one of our Soviet scientists added: *"...they can be*

interpreted in two ways. One, as confirmation of the vital activity of microscopic organisms, and the other, as the result of chemical reactions unknown to the researchers."

So that hope does not extinguish completely, we will say: This experiment was based on the assumption that Martian microorganisms must be similar to those on Earth. However, they could be completely different and, therefore, their behavior may be entirely unexpected for us.

In the interior of the stations during the experiments there was heat: five, ten, or more degrees above zero. For Martian inhabitants, accustomed to living always in the cold, with climates up to minus 85° below zero, such a temperature would be unbearable and even deadly.

It is very possible that the Martian microorganisms, living always in conditions of intense cold, only know how to use frozen water and not liquid water. And the Viking was giving them liquid water all the time.

Finally, some eminent scientists, such as the American astrophysicist Carl Sagan, consider that the supposed life on Mars does not necessarily have to encompass the entire planet, as on Earth. It could be concentrated in "oases," where the conditions are favorable for them.

IN THE FUTURE

Well, dear readers. We have guided you through the path traveled in the last hundred years by those who have studied Mars and those who have been interested in this planet. This book has given us the opportunity to share the expectations and disappointments, joys and sorrows of those who debated between dreams and realities, confusing wishes with true facts. In the end, it began with dreaming about the existence of Martians only to later not find even microbes on Mars.

What does all this mean? A failure? A shameful page in the history of science? Didn't the scientists discover different things than what they were looking for? And finally: is it worth telling this whole "sad story"? How is it that science appears here somewhat defenseless, the scientists confused, and the results obtained in over a hundred years meager and uninteresting?

But that is not the case!

This is the normal life of science. A continuous evolution from ignorance to knowledge. But this evolution is winding because there are no paths, they must be created. Thus, the pioneers of knowledge are required to have intelligence and effort; bravery and tenacity; selflessness and honesty.

Therefore, the "history of Mars" is not sad. It is heroic. It has not concluded yet. However, the balance of more than a hundred years is magnificent. Now we know many new things about Mars, the distant reddish planet in our sky.

We didn't know what the "continents," the "seas," or the "canals" of that planet were. Now we know that the "continents" are

stony plains. The "seas" are places filled with light, bare rocks, or dark stones that the sand hasn't covered. The "canals" are very dark zones distributed coincidentally in rows across the surface, which our eye connects into stripes.

We didn't know the composition or density of the Martian air. Now we know it is one hundred and fifty times less dense than ours and mainly contains carbon dioxide.

We knew nothing about the composition of the Martian polar caps or if there was water there. Now we know that their upper layer is made of "dry ice," or frozen carbon dioxide. We also know that there is no liquid water on the surface of that planet, but there is plenty of frozen water, found in the deep glaciers at the poles and within the thickness of the frozen soil (permafrost).

We didn't know if there was life on Mars. Now we know that no developed forms of life exist there; there are neither plants nor animals. No microorganisms were found. Apparently, they don't exist either...

As you can see, we have learned a lot about Mars. Especially in the last ten years, thanks to the cosmic technology that has so forcefully entered our lives. Humanity has gone out into the Cosmos. We have created space rockets capable of flying hundreds of millions of kilometers from Earth.

We have invented and manufactured automatic probes that can orbit as satellites of distant planets, photograph them from all sides, and transmit information to Earth on the basis of which we create maps.

We also invented and manufactured precise probes that can

soft-land on the surface of these planets, allowing us to observe up close and, as they say, "without leaving home," with all the details and even "touch and smell" the sand and rocks found at incredible distances, on other celestial bodies.

The exploration of new worlds is advancing on a grand scale. With the assistance of AIS (Automatic Interplanetary Stations), Soviet scientists are intensively and successfully exploring the planet Venus, our "neighbor" on the side toward the Sun. The surface of Venus is hidden from our eyes. There, beneath those thick layers of clouds, the natural conditions are much harsher for humans than those on Mars. Its atmosphere is one hundred times denser than Earth's; the heat is tremendous: 500 degrees above zero (presumably Celsius). Nevertheless, Soviet landers have already landed many times in the middle of that hell, conducting research and photographing the surrounding terrain. Other Soviet automatic spacecraft orbited the planet, "palpating" its relief with radars...

Every 76 years, Halley's Comet approaches the Sun, becoming visible in our sky. Its last visit occurred at the end of 1985 and the beginning of 1986. Automatic spacecraft were sent to meet this enigmatic celestial visitor, which photographed it up close and reported on its composition. These were two Soviet automatic interplanetary stations, "Vega-1" and "Vega-2," a European station "Giotto," and a Japanese one, "Planeta-A." The Soviet stations were the best equipped with scientific instruments. En route to the comet, the stations passed close to Venus and deployed their respective landers and aerostat-probes, which would help scientists verify the speed and directions of the winds on that planet. The scientific equipment for the "Vegas" was developed jointly by specialists from the USSR, Austria, Bulgaria, Czechoslovakia, France,

Hungary, GDR, FRG, and Poland. The encounter of the stations with Halley's Comet took place in March 1986.

But what about Mars? How can its exploration continue?

In the Soviet Union, within the framework of the international program "Fobos" (Phobos), it is planned to launch a cosmic probe toward Mars by the end of the 1980s. After passing the Martian satellite that gave the project its name, the probe will deploy a scientific equipped lander onto it and continue studying the planet itself.

In this regard, it has been proposed, for example, to continue the exploration of the planet by means of "Martekhods" (Mars rovers).

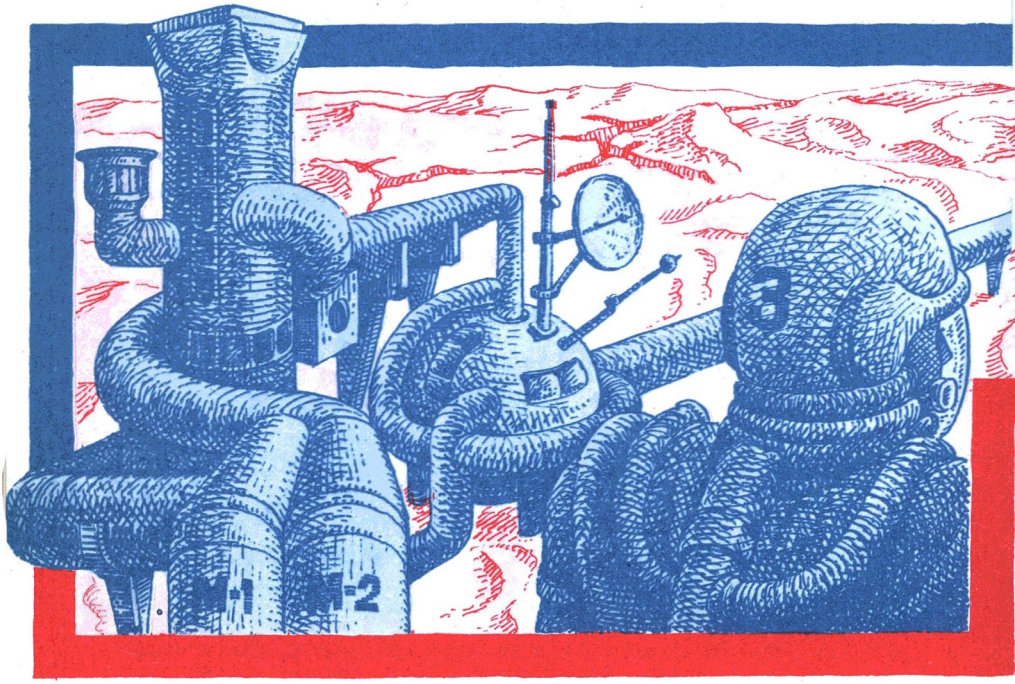
These machines must be more complicated than the Lunokhod, the lunar self-propelled vehicle, which in its time drove on the Moon and was controlled from Earth. The probes sent to Mars must have self-control, at least partially.

A radio signal needs only one and a half seconds to travel from Earth to the Moon. That is acceptable. The Lunokhod would show us a "picture" of what it was "seeing." Upon noticing a deep precipice in the picture, it was given the command to "Stop!" It stopped in a few seconds, just before reaching the precipice.

Radio signals will take about 5–6 minutes to reach Mars and another such amount to return, even during the "opposition" period. At other times, they are delayed by up to 15–20 minutes one way, and up to 40 minutes for the round trip! If the Martian rover has to consult Earth for every detail, the work will not be very productive.

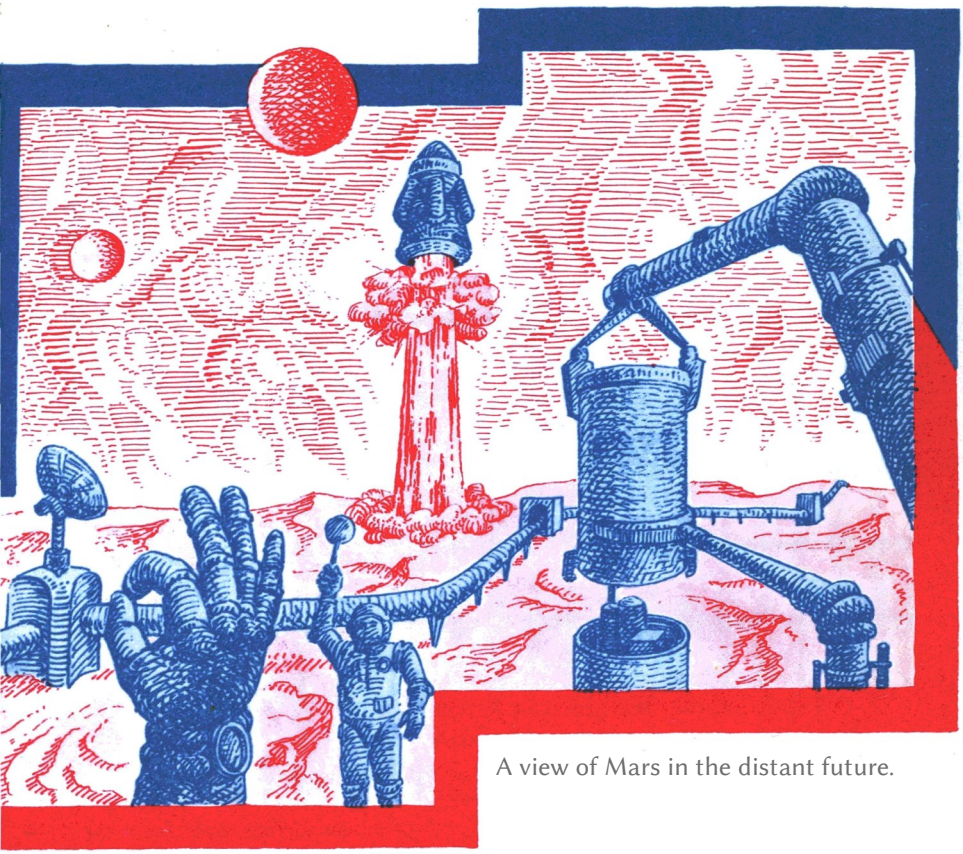
Slow-moving machines on Mars would be of little use.

We need to send "intelligent" machines, so they can autonomously choose paths, dodge obstacles, and differentiate what is interesting from what is not. And they must be able to perform everything that is important to us, such as collecting, photographing, and investigating "on the ground." Additionally, they must be very small and lightweight. Such a machine will be very complex today, and engineers face a difficult task.



However, even those probes will not be able to perform all the assigned tasks on Mars. Therefore, it is evident that man will have to fly there.

We must not forget that the flight of man to Mars is a mission



A view of Mars in the distant future.

much more complex than we imagine, and hundreds of times more costly than the flight of a probe. This is due to two basic reasons:

The first: man must return to Earth; the probe does not. The probe is sent to Mars, allowed to work, and abandoned. This means that sending a man from Earth makes it necessary to include him in what is called the "payload," where every kilogram is calculated, not to mention the hundreds of tons of fuel for the return trip. There are no service stations on Mars.

The second: during the trip, the probe neither eats nor drinks, nor does it need to breathe. Man, on the contrary, requires a

constant supply of food, water, air, and much more. These "consumable materials" must be carried along, calculated for the duration of the expedition, which would last no less than a year and a half. This is a quite considerable weight: several tons for each cosmonaut.

All of this requires a ship of immense size, and there is no talk of manufacturing it yet. The situation can be solved by sending several smaller ships, distributing the loads among them. These ships would have to be placed in Earth's satellite orbit, piece by piece, and then joined there. This, of course, is just one of the possible projects for future expeditions. It is based on the experience of the automatic interplanetary stations that performed soft landings on the Moon, Mars, and Venus, and on man's flight to the Moon.

The flight would last approximately half a year.

According to this project, the ships will have descent modules. On their flight to Mars, the ships will enter the planet's satellite orbit, where they will remain revolving around it. The descent sections, with some of the cosmonauts and essential equipment, will be landed onto the planet's surface one by one. It is possible that the descent sections will have small electromobiles so that the cosmonauts have a means of transport on Mars. After working on Mars for a few weeks, the cosmonauts will leave the electromobiles, board the recoverable modules, and fly back to orbit. There they will find their ships, with which they will dock. They will then detach the descent sections and fly back to Earth...

When will all this be carried out?

It is such a complex and costly undertaking that it must be

resolved by all of humanity united and in collaboration. Cosmic technology will allow such flights to be carried out in the next two decades. But humanity is not prepared to carry out such a massive joint effort. For this, true peace in the world is needed. The sooner it is achieved, the sooner man will fly to Mars.

In any case, some of you who are now between the ages of 12 and 16 will be exactly the right age to be cosmonauts by the end of this century. Therefore, you have the opportunity to be among those people who will step on that surprising and enigmatic planet!

We have talked about the technology that must be used in the study of Mars. Let's talk now about science itself.

Of course, the study of Mars will be oriented in several directions. People will study its surface, create detailed maps, describe the mountains and plains, the shape and composition of the stones, the movement of the sand, the distribution of moisture, the climate, the weather. Now, let's limit ourselves to talking only about the theme of this book: the problem of the existence of life on Mars.

First, we will say that the search for life on Mars was not carried out to the end. The last conclusion was: that life was possible, but it was not successfully observed. The causes are not well known, and there is almost no hope of discovering it.

What factors prevented finding life, if it exists?

Perhaps it is very different from ours, and we are not sure of taking the right path to find it.

Perhaps life is dispersed and lodges in oases or deep within the planet, and we have not yet discovered the place where it exists?

Perhaps it only emerges in the warm and humid periods, and now it is sleeping, covered in sand?

It may be that it existed in the distant past and then could not survive the difficulties that arose and withered away completely, and now we are only left to search for its traces.

Surely, work will have to be organized to verify these hypotheses. But, the most likely outcome is that they will yield no results, and then we will finally be convinced that there has been and is no life on Mars. Neither mysterious, nor hidden, nor sleeping, nor dead. And yet, this, too, will be knowledge of great value, truthful knowledge: *"Mars is a lifeless planet."*

Whatever results are obtained by the scientists, they will constitute a great contribution and will raise new and no less interesting problems.

And since we do not yet know exactly how life arose on Earth, it will be especially important for us to know the situation on Mars. Perhaps the very birth of life requires especially favorable conditions, and these are not so necessary for its evolution.

If it is confirmed that Mars is a lifeless planet, we can begin to assimilate it and populate it with terrestrial life.

This will be in a more distant future. However, we can make some conjectures.

We, the Earthlings, will take charge of doing what Nature could not achieve. Taking terrestrial life to Mars is no longer an unfounded fantasy.

Initially, terrestrial plants and microorganisms will live on Mars in laboratories. Then they will move outside.

Someday we will have sown all of the Martian soil. The plants, by absorbing carbon dioxide for many years, will saturate the planet's atmosphere with oxygen.

The time will also come when man will be able to walk on Mars without a spacesuit.

Man will begin to build cities, to plant gardens; he will create the second Earth and will then wonder why Earthlings tried for so long to find Martians on Mars. Even more so when Mars turned out to be a free, virgin territory that man could conquer for the benefit of his descendants.

And the radio stations on Earth, when communicating with the people who will have settled on Mars, will give the signal: *"Hello, hello, Martians, please respond!"*

In short, the enigmas of the Cosmos are inexhaustible. To unravel them, it is necessary to carry out an immense, interesting, and extremely passionate work; a work imbued with romanticism and creativity; a work that will offer infinite opportunities to demonstrate heroism and great discoveries; to contribute to the rise of civilization, and to increase the happiness of the illustrious tribe of Earthlings.

You, our young readers, have great possibilities to demonstrate your best qualities.

All that is needed is peace on Earth, so that humanity can fully dedicate itself to good and peaceful works, whether on our planet or in the Cosmos.

We wish you success, friends!

FROM UNCERTAINTY TO DISCOVERY: MARS SINCE THE 1990s

Damitr Mazanav

Almost 40 years have elapsed since the book was written. We have come a long way in exploration of Mars from the pioneering Soviet and US probes from the 1970s and 1980s. As we have seen in this book Mars was a planet wrapped in mystery since antiquity. The study of Mars via the telescopes, made it even more mysterious with the discovery of "canals." Only with the Viking and Mars missions of the 1970s did dispel some mystery. It was clear that future exploration needed more than that.

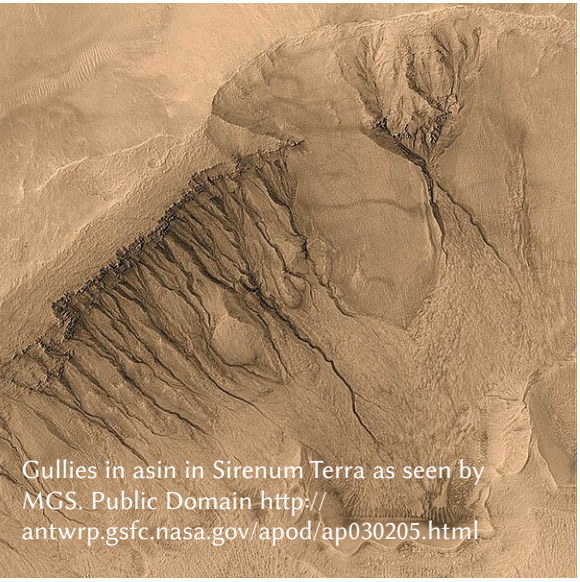
That future is now here. Since the 1990s, our knowledge of Mars has grown in leaps and bounds. Our guesses and theories have transformed to known facts, thanks to data from a number of orbiters and intelligent rovers exploring the red planet over last few decades. We now have unprecendented hi-resolution images of Martian surface and data about its composition, weather and features. The surface rovers have provided us with a wealth of information about physical structure, chemical composition and weather patterns on Mars. The orbiters have provided hi-resolution birds-eye-view of Martian "continents" and "seas." Our knowledge about Mars is increasing by the day, and will continue to increase over next decades.

Let us briefly look at what we have achieved in the last forty years or so.

Mars Global Surveyor (1996-2006)

The *Mars Global Surveyor* (MGS) was an American space probe lauched in 1996 that arrived on Mars in 1997. As the name suggests the probe began mapping the entire planet from the ionosphere down through the atmosphere to the surface, and found dramatic evidence that water still flows briefly down hillside gullies. The *MGS* did continuous weather monitoring and changes of the Martian surface due to wind and ice. It also explored potential sites for landing of later Martian missions.

Artist concept of the Mars Global Surveyor. Pulic Domain https://photojournal.jpl.nasa.gov/jpeg/PIA17486.jpg



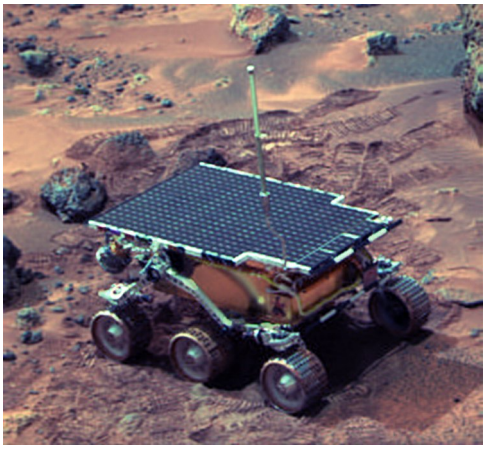
Gullies in asin in Sirenum Terra as seen by MGS. Public Domain http://antwrp.gsfc.nasa.gov/apod/ap030205.html

The MGS had five major scientific instruments, the Mars Orbiter Camera provided us with more than 240,000 hi-res detailed images of Martian surface. One of the major discoveries of MGS was that it found evidence for water flow on Mars in the

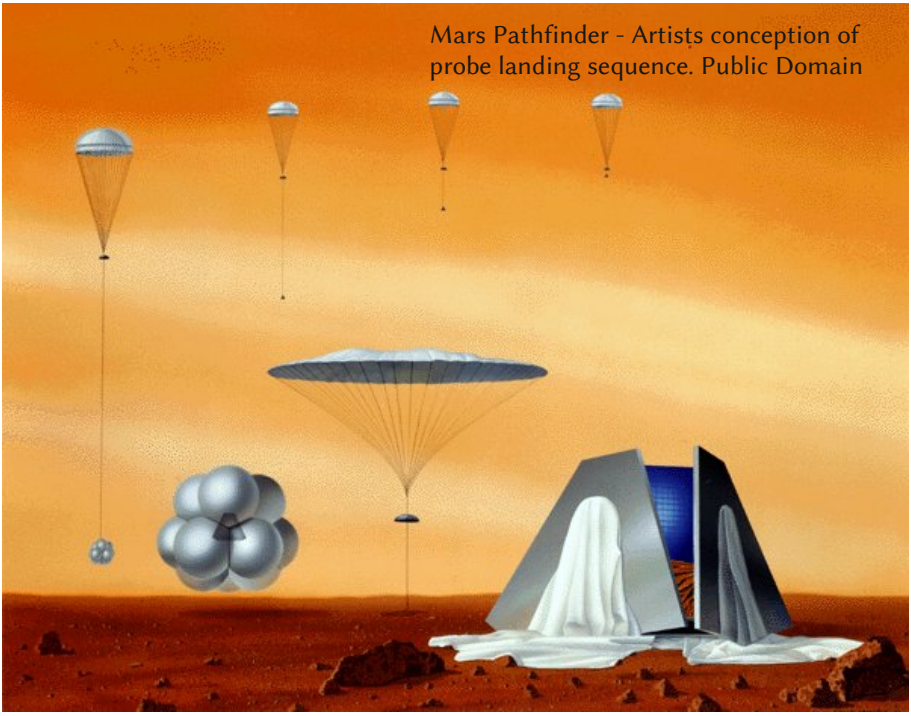
form of gullies. MGS was operational till 2006.

Mars Pathfinder (1997-1998)

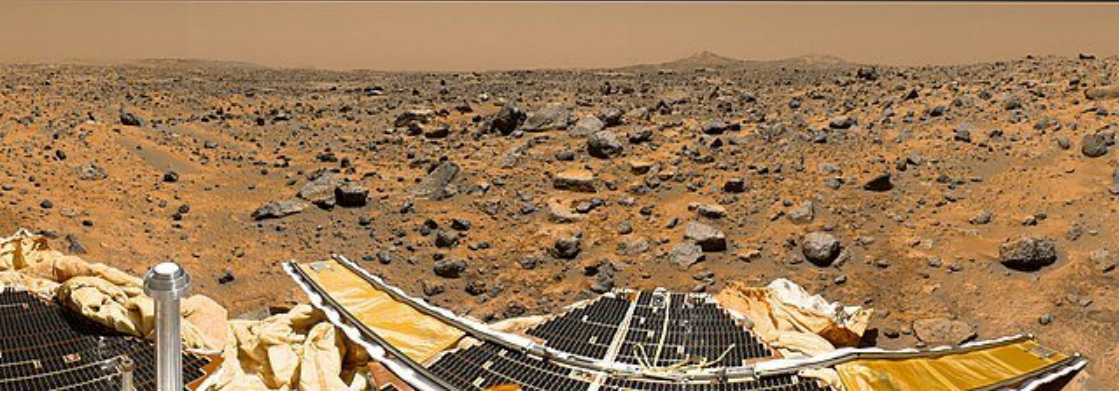
The *Mars Pathfinder* mission was a ground-breaking NASA project that landed a base station and the *Sojourner* rover on Mars in 1997, marking the first successful rover operation outside the Earth-Moon system.



Sojourner rover pictured by Pathfinder lander. Public Domain https://photojournal.jpl.nasa.gov/catalog/PIA01122



Mars Pathfinder - Artists conception of probe landing sequence. Public Domain



Mars Pathfinder panorama of landing site taken by IMP. Public Domain
https://photojournal.jpl.nasa.gov/catalog/PIA01466

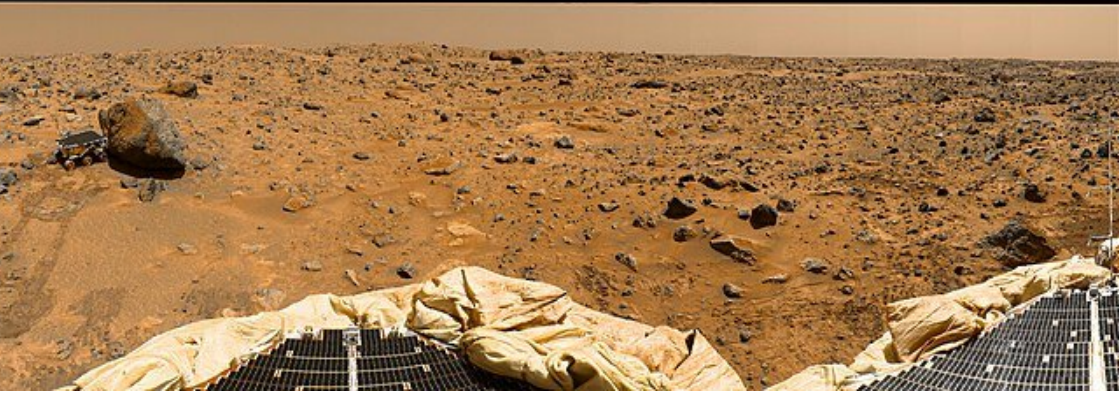
It demonstrated innovative technology such as airbag-assisted landing and automated obstacle avoidance, vastly reducing mission costs and development time compared to previous Mars missions.

The rover explored the Martian surface, travelling about 100 metres and analysing the composition of rocks and soil using its spectrometer, revealing evidence of past volcanic activity and presence of water. The lander conducted extensive meteorological measurements, including temperature, pressure, and wind data, while capturing thousands of images, some of which provided a panoramic view of the landscape.

Pathfinder's success proved the feasibility of cost-effective, rapid planetary exploration, influencing future Mars rover missions and greatly expanding our understanding of Mars' geology and atmosphere.

A sunset on Mars captured by Pathfinder.
Public Domain

The mission also served as a vital testbed for

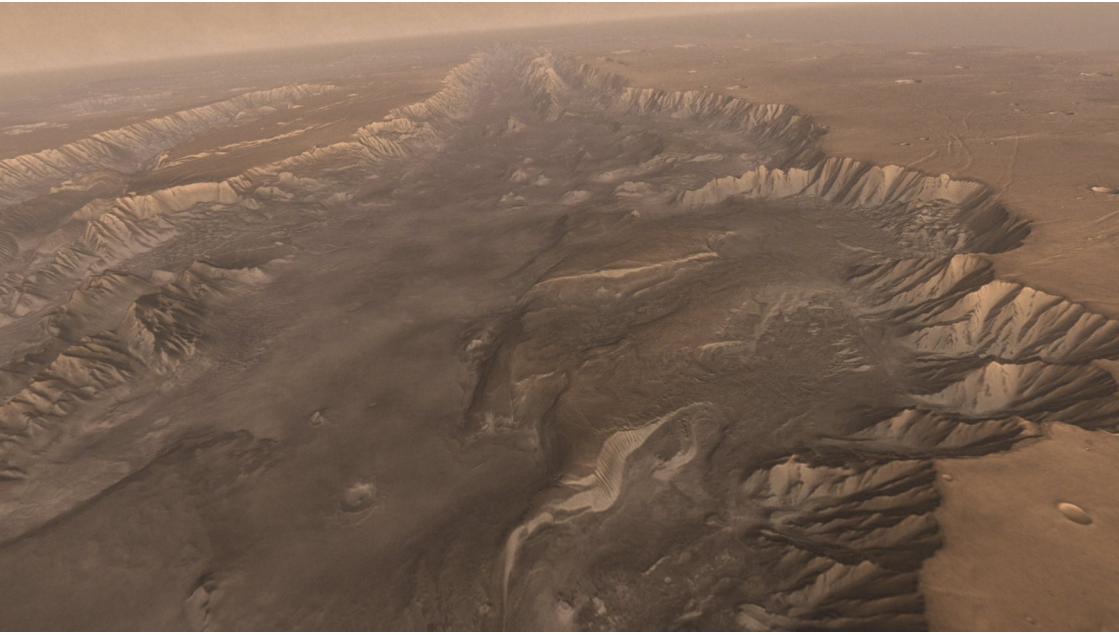


technology and scientific instruments critical to further exploration of Mars.

Artist concept of the Mars Odyssey.
Pulic Domain http://www.fourth-millennium.net/mission-artwork/2001-mars-odyssey-over-valles-marineris.JPG

Mars Odyssey (2001)

Mars Odyssey was a NASA probe that was launched in 2001. The name is an ode to Arthur C. Clarke's famous science fiction story *2001: A Space Odyssey*. *Mars Odyssey* used three primary instruments: Thermal Emission Imaging System (THEMIS) for visible and infrared photographs, Gamma Ray Spectrometer (GRS) for searching various elements in Martian atmosphere, and Mars Radiation Environment Experiment (MARIE) for measuring radiation levels around Mars. *Mars Odyssey* mission was the first spacecraft to make a global map of the chemical elements and minerals that make up the Martian surface.



NASA's *Mars Odyssey* orbiter captured breathtaking views of Valles Marineris, the largest canyon in the solar system. This immense canyon stretches about 4,000 kilometers long and can be up to 7 kilometers deep, nearly the height of Mount Everest. Its steep walls and side canyons suggest they were partly shaped by ancient water flows and massive landslides that spilled across the canyon floor. The canyon extends across almost a quarter of Mars' circumference, cutting through the planet's equatorial region.
Public domian https://science.nasa.gov/mission/odyssey/

Designed to study the composition, geology, and radiation environment of Mars, it created the first global map of chemical elements and minerals on the Martian surface. One of its earliest and most significant discoveries was the detection of hydrogen beneath the planet's surface, a strong indication of water ice, which reshaped scientists' understanding of Mars' potential for past or present life. This find directly inspired later missions such as the Phoenix lander, which confirmed the presence of frozen water in 2008.

Using its instruments *Mars Odyssey* has continuously monitored surface minerals, atmospheric conditions, and ra-dia-tion levels crucial for planning human exploration. The orbiter has also served as a trusted communications relay,

transmitting data between Earth and later NASA rovers.

As of 2025, the Mars Odyssey mission is still operational, making it the *longest continuously active mission* in orbit around a planet other than Earth. It studies clouds, fog, and frost, maps rocks on the surface to help make future landings safer, and has already gone around Mars more than 100,000 times!

Mars Express (2003)

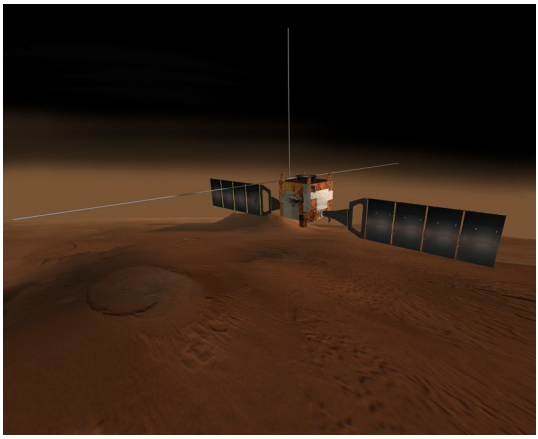


Illustration of ESA's Mars Express spacecraft. Public Domain https://marsprogram.jpl.nasa.gov/express/gallery/artwork/hires/mars-express-volcanoes-sm.jpg

The European Space Agency's *Mars Express*, launched in 2003, marked Europe's first successful mission to another planet and remains one of the longest-operating orbiters around Mars. Its dual focus on deep space science and technological innovation has revolutionised our understanding of the red planet. The mission's orbiter continues to map the Martian surface in high resolution, analyse mineral composition, and study atmospheric circulation and climate dynamics. Early findings included the detection of water ice in the planet's south polar cap, hydrated minerals on the surface, and methane in the atmosphere. This suggests both past water activity and potential geological or biological processes. Even after the loss of its lander, *Beagle 2*, Mars Express proved a resounding success,

maintaining continuous operations and significantly contributing to scientific collaboration between ESA and NASA.

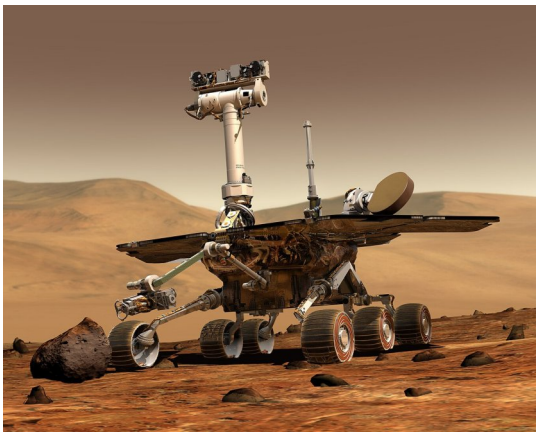
Photo of the Louth Crater on Mars taken by Mars Express in 2005. CC https://en.wikipedia.org/wiki/File:Louth_Crater_-_Mars_-_February_2_2005_(32392673600).jpg

Mars Express carries a suite of powerful instruments including the High-Resolution Stereo Camera (HRSC), the OMEGA infrared mineralogical spectrometer, and the MARSIS radar sounder, which enabled the detection of subsurface water ice and even possible liquid lakes beneath the south polar ice cap. Its imaging and spectroscopic data have revealed evidence of ancient river valleys, volcanic activity, and large-scale geological transformations that imply a once warmer and wetter climate. The spacecraft has also examined how solar wind and radiation interact with the Martian atmosphere, helping to track atmospheric escape processes that shaped Mars' evolution over billions of years.

Today, more than two decades since its arrival, *Mars Express* continues to deliver cutting-edge science and vital communications support to other Mars missions. Its long-term mapping projects have produced a near-complete 3D atlas of the Martian surface, while radar studies have uncovered hidden structures beneath ice and rock.

Above: A hi-res image of Phobos taken by Mars Express in 2010 using the The High Resolution Stereo Camera (HRSC).
CC BY-SA 3.0 IGO) licence
https://en.wikipedia.org/wiki/File:Phobos,_taken_on_7_March_2010_(11606120483).jpg
Below: Olympus Mons, HRSC image.
By Jackie Branc - Own work, CC BY 4.0, https://commons.wikimedia.org/w/

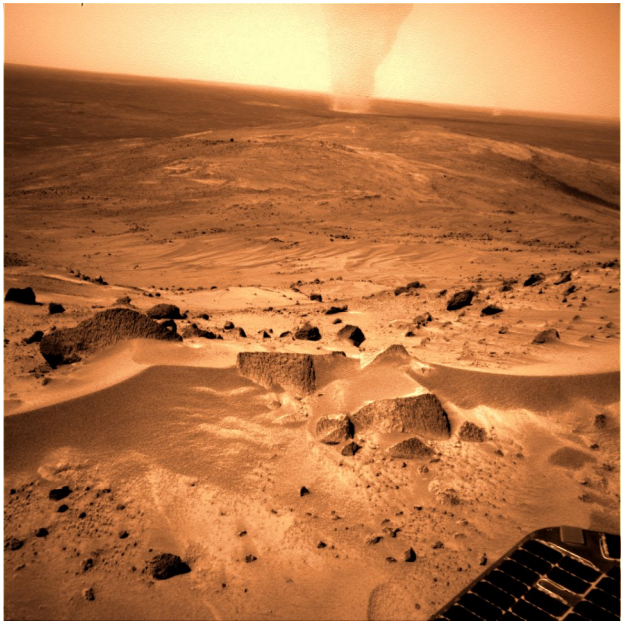
Mars Exploration Rover – Spirit and Opportunity (2003-2018)



An artist's concept portrays a NASA Mars Exploration Rover on the surface of Mars.
Public Domain
https://photojournal.jpl.nasa.gov/catalog/PIA04413

NASA's *Mars Exploration Rover* (MER) mission, launched in 2003, sent twin robotic rovers, *Spirit* and *Opportunity*, to explore opposite sides of Mars, marking one of the most successful planetary missions in history. Designed for 90-day missions, both rovers far exceeded expectations: *Spirit* operated for over six years and Opportunity explored for nearly fifteen. *Spirit* transferred 128,224 pictures in its lifetime. Together, they provided irrefutable evidence that liquid water once existed on Mars by identifying rocks, minerals, and soil patterns shaped by water activity. Opportunity's discovery of hematite-rich "blueberries" at *Meridiani Planum* and *Spirit's* identification of silica and goethite in *Gusev Crater* revealed that ancient Mars was warmer and wetter, conditions that could once have supported microbial life.

Both rovers achieved remarkable engineering and scientific feats. *Spirit* climbed the *Columbia Hills*, returning panoramic images and uncovering altered volcanic rocks showing traces of aqueous processes, while *Opportunity* set the off-Earth distance record by travelling over 45 kilometres across the planet's surface. They analysed hundreds of rocks using



Spirit captures a Martial "dust devil on 21 August 2025" inside Gusev Crater. CC BY SA 3.0
By NASA/JPL; modified/coloured by D Mitriy https://commons.wikimedia.org/w/index.php?curid=15339241

instruments like the Alpha Particle X-ray Spectro-meter and Mössbauer spectrometer, confirm-ing complex geological histories shaped by wind, water, and volcanic activity. Their ability to withstand severe dust storms and operate autonomously for years demonstrated the

Heat Shield Rock photographed by Opportunity Rover turned out to be the first iron meteorite discovered on Mars. Public Doman
By NASA/JPL
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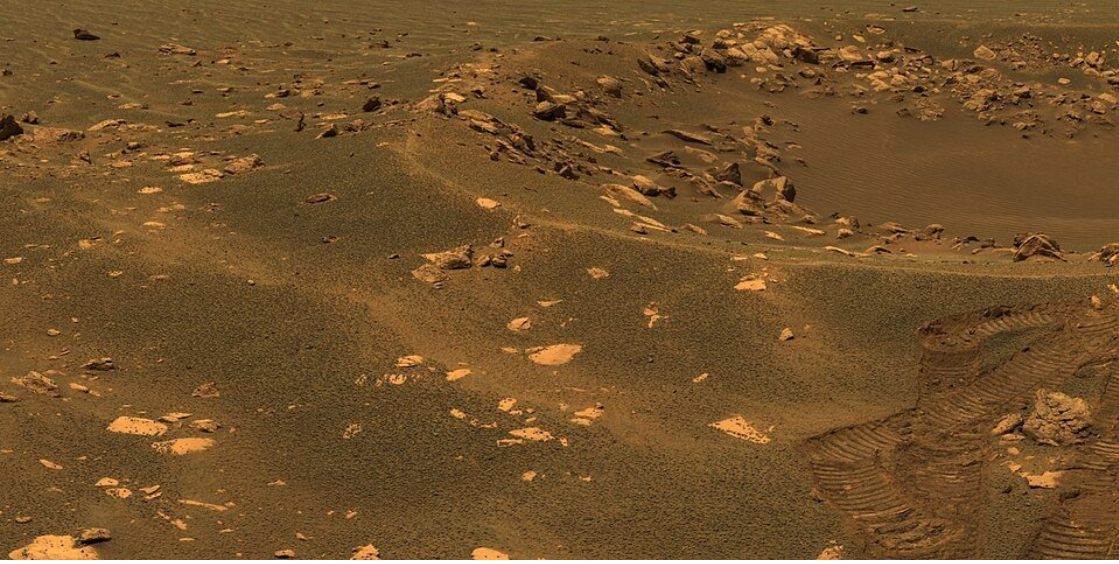
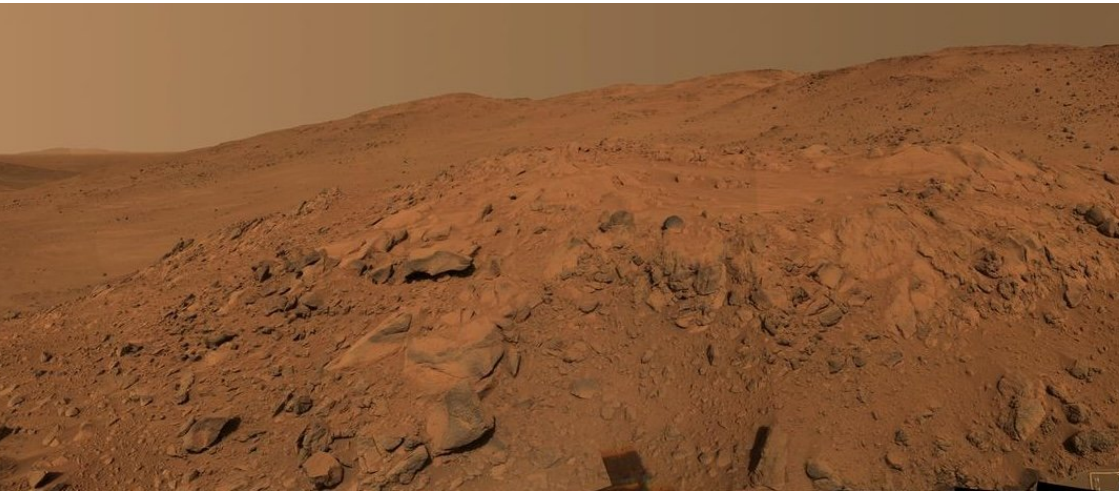


A photo by Opportunity showing details of an impact crater called "Fram" in the Meridian Planum region of Mars. It is a mosaic made from photos taken by NASA's Mars rover Opportunity on its 88th day on Mars, 23 April 2004. The crater

resilience of NASA's rover technology and paved the way for later missions.

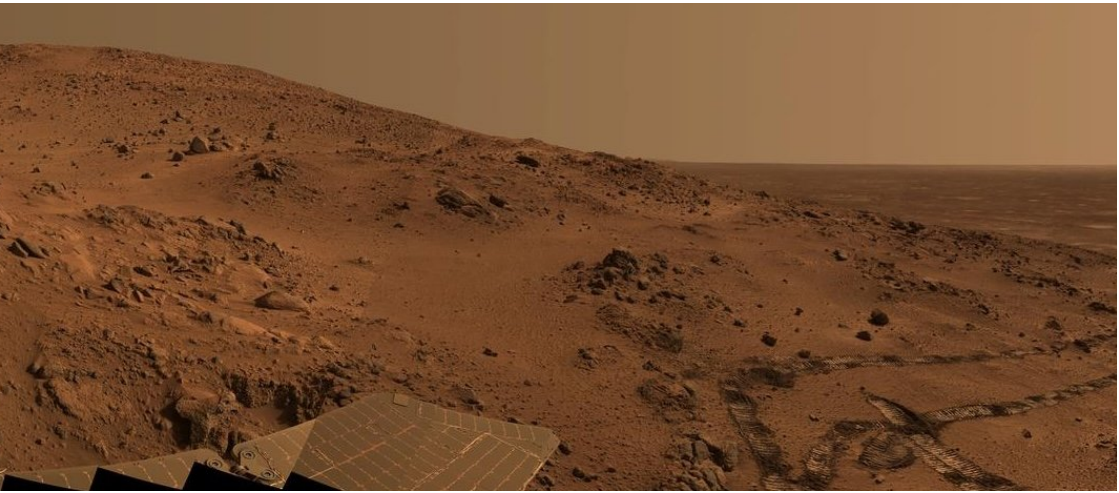
The MER mission transformed humanity's understanding of Mars from a seemingly dead world into a dynamic planet with a watery past. It set the stage for astrobiological exploration,

Color panorama taken by Spirit from "Larry's Lookout". On the far left is "Tennessee Valley" and on the right, rover tracks. Public Domain https://commons.wikimedia.org/wiki/File:Spirit_Lookout_L256t-A413R1_br2.jpg

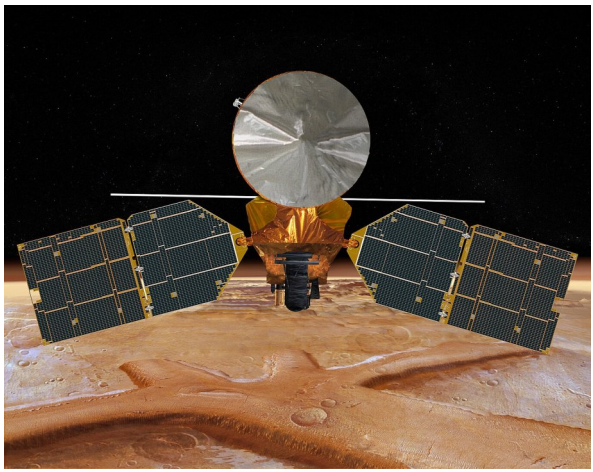


is about 8 metres (26 feet) wide.
Public Domain https://marsrovers.jpl.nasa.gov/gallery/press/opportunity/20040526a.html

influenced the design of modern rovers, and fostered enduring public engagement through its longevity and human-like perseverance. *Spirit* and *Opportunity* remain iconic symbols of exploration, machines that journeyed across alien terrain and rewrote the story of Mars for an entire generation.



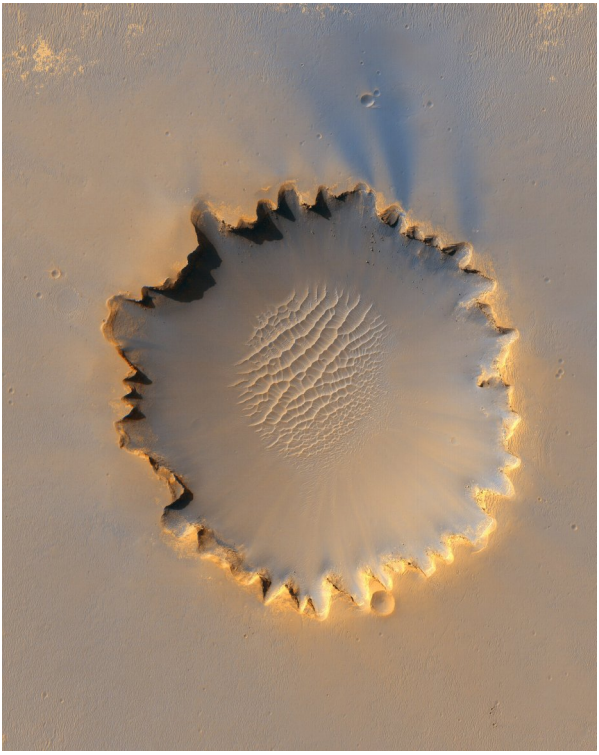
Mars Reconnaissance Orbiter (2005)



Artist's concept of NASA's Mars Reconnaissance Orbiter. Public Domain from NASA https://photojournal.jpl.nasa.gov/jpeg/PIA07245.jpg

Launched in August 2005 and arriving at Mars in March 2006, NASA's *Mars Reconnaissance Orbiter* (MRO) has revolutionised our understanding of the Red Planet. Equipped with some of the most powerful instruments ever sent to another world, including the high-resolution HiRISE camera, the CRISM spectrometer, and the SHARAD radar, it has mapped the Martian surface in unprecedented detail, revealing past river channels, sedimentary layers, and minerals that formed in the presence of water. MRO's discoveries confirmed that Mars once had environments capable of supporting life, such as the detection of hydrated clays, carbonates, and slopes, which once appeared to suggest liquid water flows.

Beyond its scientific achievements, MRO has been a cornerstone of NASA's Mars Exploration Program. Acting as a high-speed communications relay, it has transmitted vast amounts of data to Earth and played a vital role in guiding and supporting multiple missions, including *Phoenix*, *Curiosity*, *InSight*, and *Perseverance*. Its data have been used to select safe and scientifically valuable landing sites for rovers and landers,



This stunning high-resolution image from MRO's HiRISE shows Victoria Crater near Mars's equator. About 800 metres wide, the crater has a rim shaped by erosion, layered rock walls, and a floor covered with dark sand dunes and fallen boulders.

Public Domain from NASA
https://photojournal.jpl.nasa.gov/catalog/PIA08813

providing real-time descent imaging of spacecraft as they reached the Martian surface. The orbiter's exceptional precision and durability have allowed it to operate almost two decades beyond its original mission plan.

MRO's long-term observations of climate, weather patterns, and seasonal surface changes have made it an essential tool for understanding Mars as a dynamic world. With HiRISE and MARCI, it continuously monitors dust storms, ice deposits, and atmospheric conditions, offering insights into the planet's evolution and preparing for future human exploration. The MRO has many more years left in its operation and enough fuel to last till 2035.

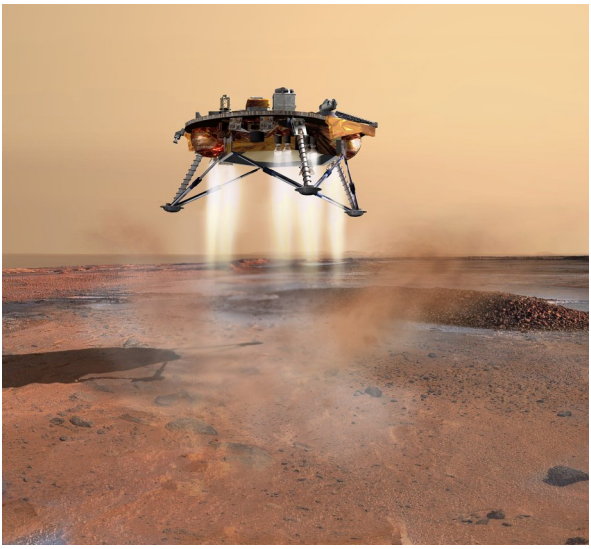
The University of Arizona's HiVIEW a HiRISE image explorer allows you to explore the images on your own!

https://www.uahirise.org/hiview/

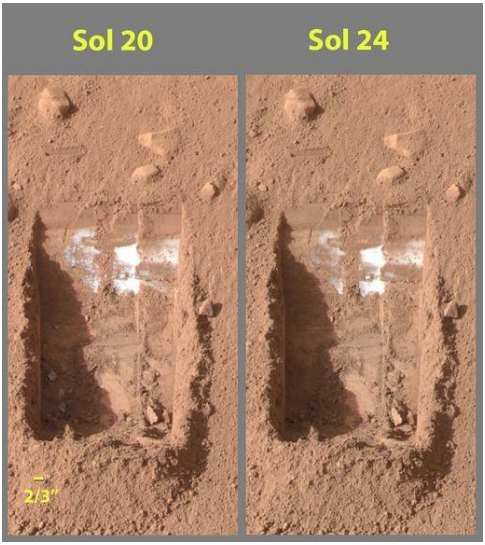
Above: The a location on Mars associated with the best-selling novel and Hollywood movie, "The Martian", the landing site of Ares-3. Public Domain Courtesy NASA/JPL-Caltech https://photojournal.jpl.nasa.gov/jpeg/PIA19913.jpg
Below: HiRISE captured these enhanced-color images of Deimos, the smaller of the two moons of Mars, on 21 February 2009. Public Domain NASA/JPL-Caltech/UArizona https://www.uahirise.org/releases/deimos/

Phoenix (2008)

The *Phoenix Mars Lander*, launched in 2007 and landing in May 2008, was NASA's first mission to explore the Martian Arctic and the first under its "Scout" program of low-cost, focused spacecraft. Its aim was to follow the water, quite literally, by digging into Mars's icy soil in search of clues about the planet's wetter past and its potential to have once supported life. Phoenix landed in Vastitas Borealis, a region comparable to



An artist's rendition of the Phoenix Mars probe during landing.Public Domain By NASA/JPL/Corby Waste - http://www.nasa.gov/mission_pages/phoenix/multimedia/pia09943.html

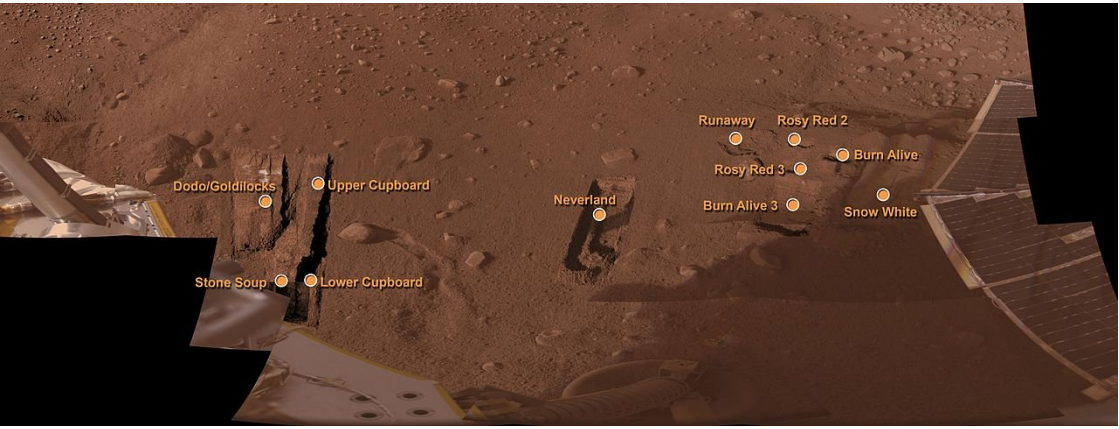


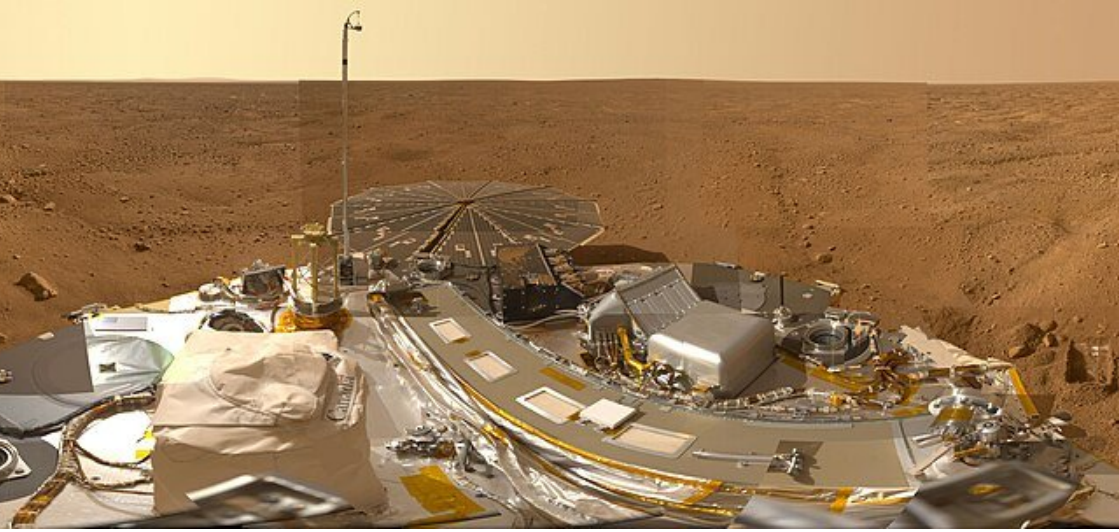
Side-by-side images of a trench dug by Phoenix's robotic arm, showing the sublimation of material – three whitish clumps in the lower left corner of the trench – presumed to be water ice, over the course of four days (Sol 20 to Sol 24). Public Domain by NASA https://en.wikipedia.org/wiki/File:Phoenix_17_sol_20_to_24_change_dodo.jpg

This panoramic view, built from over 100 images taken in the first weeks after NASA's Phoenix Lander touched down on 25 May 2008, shows its arctic landing site on Mars. The true-colour mosaic reveals polygonal ground patterns like those

Earth's Arctic tundra, where it conducted on-the-spot scientific experiments using its robotic arm and laboratory-grade instruments to study the chemistry and structure of the soil.

This mosaic of images taken by NASA's Phoenix Mars Lander's Surface Stereo Imager shows Phoenix's workspace, informally named "Wonderland," with the major trenches and features that have been informally named as of Sol 84 (August 19, 2008), the 84th Martian day after landing. Public Domain by NASA/JPL-Caltech/University of Arizona/Texas A&M University
https://photojournal.jpl.nasa.gov/catalog/PIA11044





in Earth's permafrost. Visible are the lander's deck, solar panels, meteorology mast, and trenches dug by its robotic arm to study the icy soil. Public Domain by NASA/JPL-Caltech/University of Arizona/Texas A&M University https://photojournal.jpl.nasa.gov/catalog/PIA13804

Phoenix quickly confirmed one of the most fundamental discoveries in modern planetary science—the presence of water ice just beneath the Martian surface—proving earlier hints from orbit to be correct. Its onboard laboratory also detected perchlorate salts, minerals that (on Earth) can serve as energy sources for microbes and may influence how Martian ice melts. *Phoenix* recorded alkaline soils, unexpected for Mars, containing compounds such as calcium carbonate that typically form in the presence of liquid water. These findings suggested that, at least in its distant past, the Martian Arctic might have been a more hospitable place than scientists had imagined. To top it off, the lander's Canadian-built weather station detected snowfall from thin clouds—offering the first proof that it snows on Mars.

Though designed for just 90 Martian days, *Phoenix* lasted 152 sols before the onset of the Arctic winter froze its solar panels and communications ended. In its brief life, the spacecraft achieved what no one had before: it touched frozen Martian ground, tasted its contents, and showed that beneath Mars's

barren surface lies a record of past climate and chemistry—a chapter in the planet's story that continues to shape our search for life across the solar system

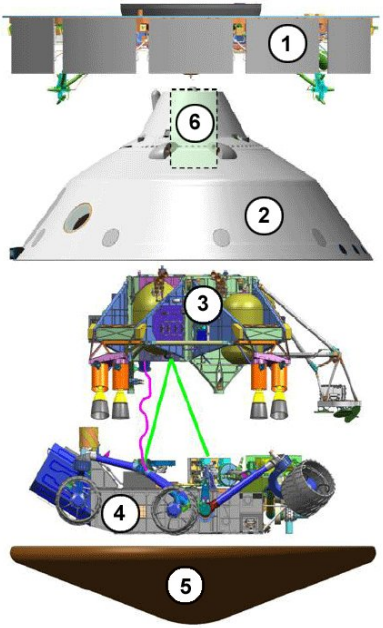
Approximate-color photomosaic of thermal contraction crack polygons in Martian permafrost.
Public Domain by NASA
https://en.wikipedia.org/wiki/File:Phoenix_mission_horizon_stitched_high_definition.jpg

Mars Science Laboratory – Curiosity (2012)

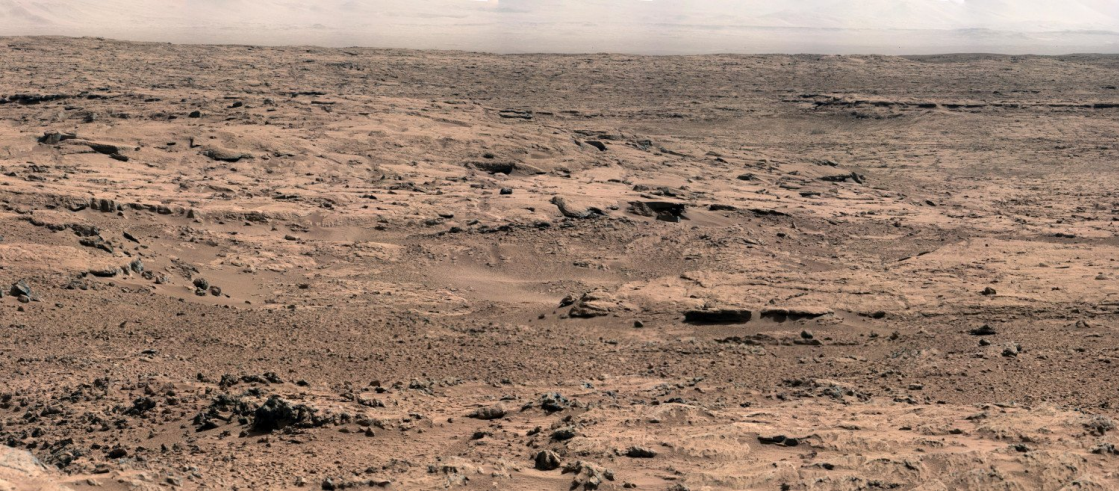
The *Mars Science Laboratory* (MSL) mission, featuring the *Curiosity* rover, marked a major leap forward in our exploration of Mars. Launched in 2011 and landing in *Gale Crater* on August 6, 2012, *Curiosity* was designed as a state-of-the-art mobile laboratory, a car-sized robot packed with sophisticated scientific instruments.

The mission's primary goal was bold: to determine if Mars ever had environmental conditions favourable for life. This meant not just driving around and taking pictures, but examining Martian rocks, soil, and atmosphere for chemical signatures of past habitability and

A selfie by Curiosity rover at "Rocknest," the spot in Gale Crater where the mission's first scoop sampling took place. Public Domain from NASA https://photojournal.jpl.nasa.gov/catalog/PIA16239

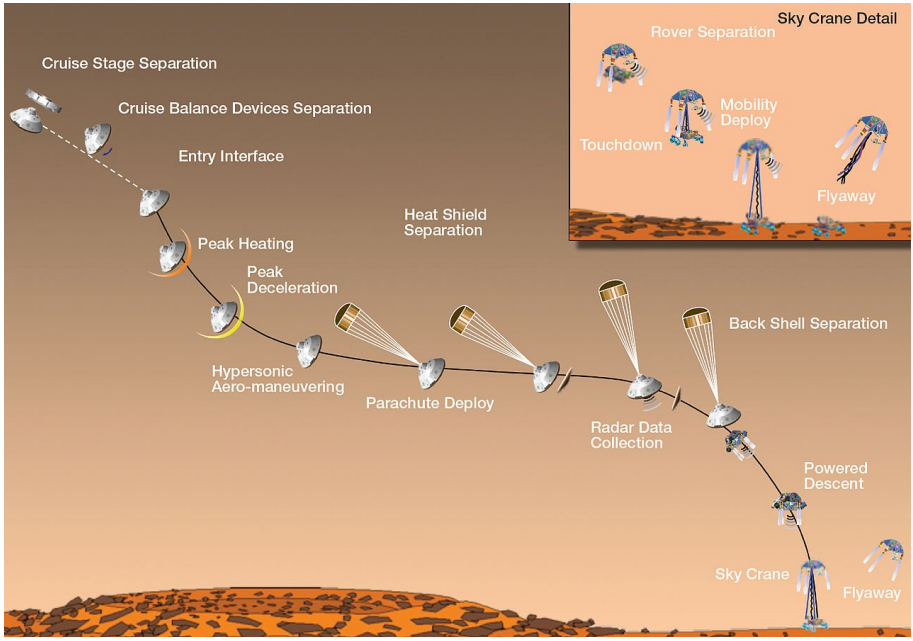


Exploded view of the five major stages of the MSL spacecraft: 1 Cruise stage, 2 Backshell, 3 Descent stage, 4 Rover, 5 Heatshield, 6 Parachute Public Domain fromNASA



Curiosity's panaromic view from Rocknest looking east toward Point Lake (center) on the way to Glenelg (November 26, 2012). Public Domain by NASA https://photojournal.jpl.nasa.gov/jpeg/PIA16453.jpg

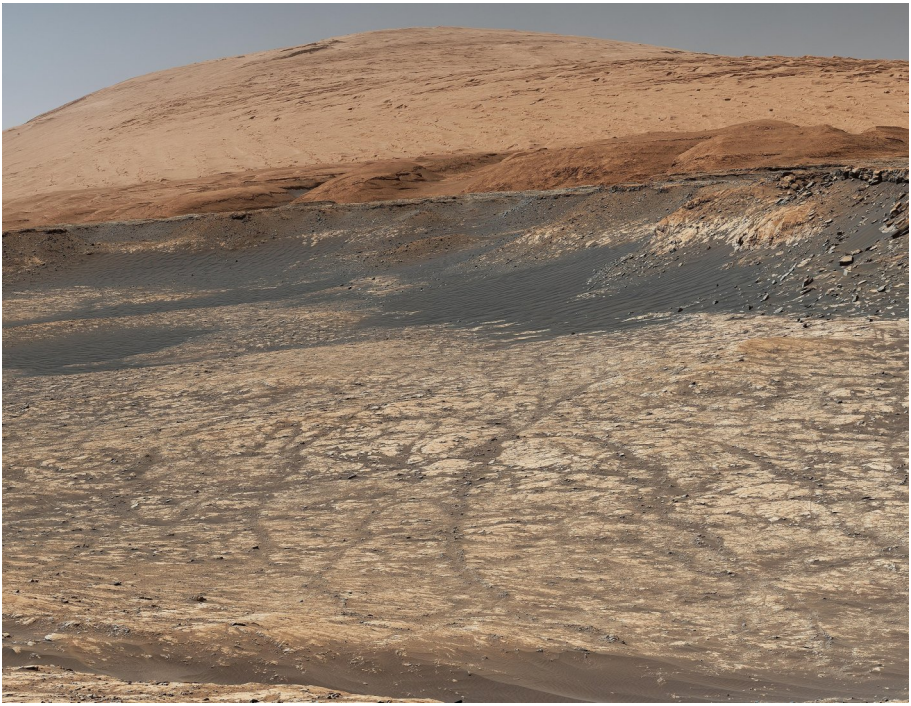
Curiosity's EDL team releases a timeline for mission milestones (depicted in this artist's concept) surrounding the landing of the Mars rover. Public Domain by NASA/JPL-Caltech
https://en.wikipedia.org/wiki/File:675608main_edl20120809-full.jpg



potential biosignatures.

Upon landing, *Curiosity* instantly made history. Its daring "sky crane" landing system, a world-first, set the one-tonne rover wheels-first onto the surface in spectacular fashion. Once safely on Mars, the rover set about exploring *Gale Crater*, a place chosen for its intriguing layers that record eons of Martian history. Using its suite of cameras, spectrometers, and a laser that could zap rocks from a distance, Curiosity quickly found mineral and chemical evidence that Mars once hosted liquid water in lakes and streams. Among its most significant discoveries were clays and sulfates, minerals that form in water, proving that *Gale Crater* once contained a long-lived, potentially habitable lake.

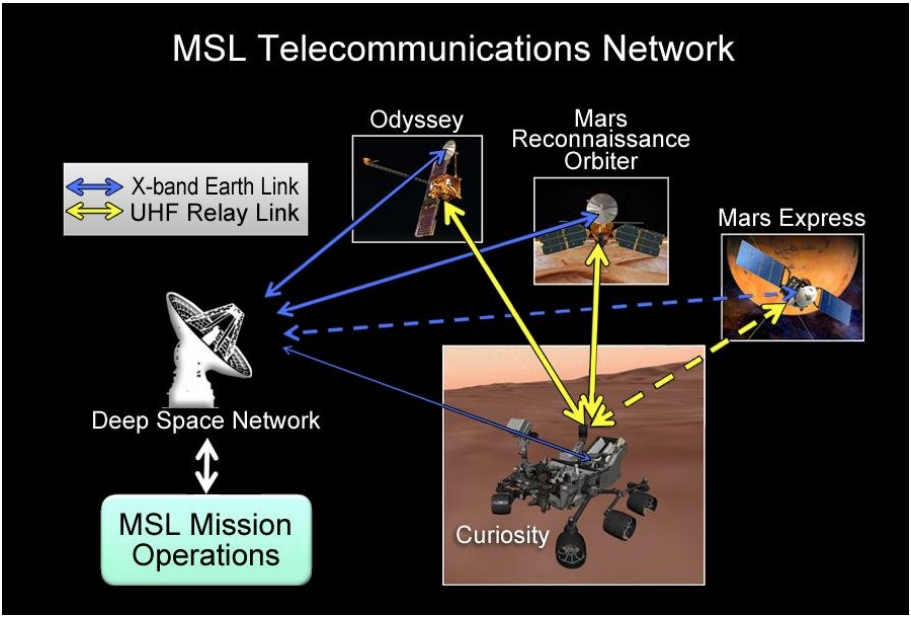
The rover's onboard laboratory went even further, detecting ancient organic molecules (the carbon-rich basics of life) and key elements like sulfur, nitrogen, and phosphorus, all considered essential for life as we know it. *Curiosity* has also made fundamental discoveries about the Martian atmosphere, such as seasonal fluctuations in methane that keep scientists guessing about possible sources—ranging from ancient geological processes to perhaps dormant subsurface life. In addition, *Curiosity's* radiation sensors measured the harsh



This panorama, stitched from 116 images taken by NASA's Curiosity rover on 10 January 2020, shows its planned route up Mount Sharp toward the sulfate-bearing unit. To reach this region, Curiosity must drive around a large sand patch. The image, white-balanced to resemble Earth daylight, highlights the layered slopes of the 5-kilometre-tall mountain. Public Domain by NASA/JPL-Caltech https://www.jpl.nasa.gov/news/news.php?feature=7692

Martian environment, giving scientists vital data for future human missions.

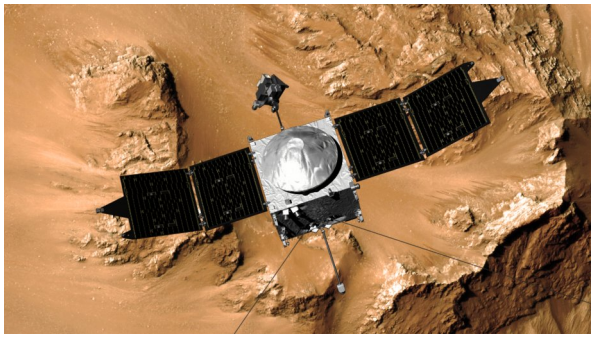
Technologically, *Curiosity* pushed the boundaries of robotics and space science. Its nuclear power source has kept it roving far beyond its original two-year mission, and as of late 2025, it continues to scale *Mount Sharp*, uncovering new chapters of Mars's story with every metre climbed. Along the way, it's snapped hundreds of thousands of images—including an astonishing 1.8-billion-pixel panorama—providing both new science and breathtaking views for the public back on Earth.



Curiosity transmits to Earth directly or via three relay satellites in Mars orbit. While the rover can send direct messages, it communicates more efficiently with the help of spacecraft in Mars orbit, including NASA's Odyssey and Mars Reconnaissance Orbiter, and the European Space Agency's Mars Express.
Public Domain by NASA/JPL-Caltech
https://photojournal.jpl.nasa.gov/catalog/PIA16106

Curiosity's most profound achievement has been its demonstration that ancient Mars possessed the conditions necessary for microbial life: water, energy, and the right chemistry. Its discoveries have reshaped our understanding of the Red Planet, transformed our approach to searching for life beyond Earth, and laid the groundwork for the next wave of Mars exploration, including the *Perseverance* rover, which is directly modelled on *Curiosity's* successful design.

MAVEN (2014)

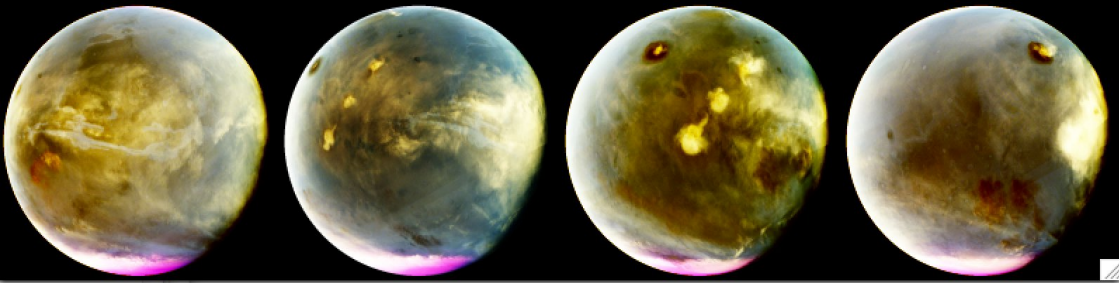


An artists rendering of MAVEN looking at the surface of Mars. Public Domain by NASA https://commons.wikimedia.org/wiki/File:Maven_mars_surface_1.png

MAVEN the *Mars Atmosphere and Volatile Evolution* mission was launched by NASA in 2013 and entered Mars orbit in September 2014 as the first dedicated effort to unlock what happened to the planet's ancient atmosphere. While Mars today is cold and dry with a thin veil of air, abundant evidence shows that billions of years ago it was wetter and warmer, likely boasting rivers, lakes, and perhaps even seas. MAVEN's central question: How did Mars lose its atmosphere, and by extension, its water and habitability?

MAVEN orbits deep enough to sample the upper atmosphere, yet high enough to watch how Mars interacts with the Sun's relentless solar wind. The spacecraft found that solar wind and radiation were, and are, the key players, stripping away the planet's atmosphere in dramatic fashion, especially during solar storms. MAVEN directly measured this loss, showing that even today, Mars sheds about 100 grams of gas per second into space. It showed that in the planet's history, such loss, especially during more active periods of the Sun, was potent enough to transform Mars from a potentially life-supporting world into the barren one we see now.

Among its most striking discoveries are the Martian auroras:

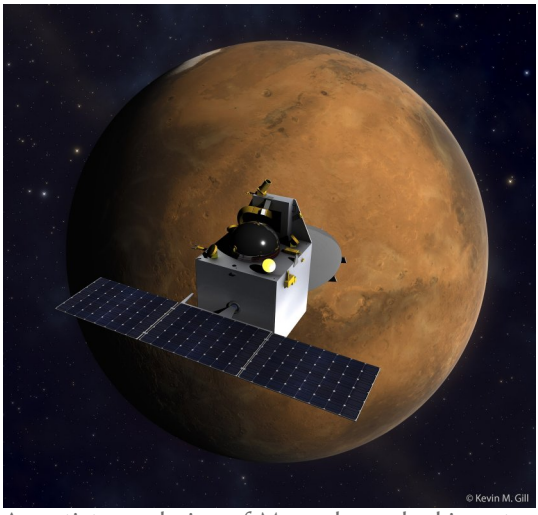


Ultraviolet Mars Reveals Cloud Formation: The ultraviolet colors of the planet have been rendered in false color, to show what we would see with ultraviolet-sensitive eyes. This images uses four MAVEN images to show about seven hours of Mars rotation during this period, and interleaves simulated views that would be seen between the four images. Public Domain by NASA/MAVEN/University of Colorado https://science.nasa.gov/mission/maven/

unlike Earth's, which cluster near the poles, Mars's auroras can appear nearly anywhere across the sky, reflecting how the solar wind bombards the planet without a global protective magnetic field. MAVEN discovered a peculiar type of "proton aurora" unique to Mars, caused when solar wind protons directly interact with the Martian atmosphere, resulting in ghostly glows that signal intense atmospheric activity. MAVEN also found that the atmosphere's escape rate is not steady, it surges when Mars is closest to the Sun or during solar events, and it even watched a nearby comet's passage spark intensified atmospheric loss.

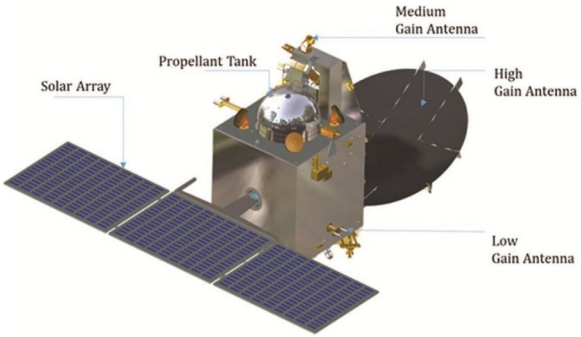
Beyond science, MAVEN has been vital as a communication relay between Earth and surface rovers. Its continued operation, and clever engineering adaptations as its components aged, ensure MAVEN is likely to support both science and exploration for Mars missions into the 2030s. All told, MAVEN has reshaped our understanding of how planetary climates evolve, highlighting how even a planet brimming with promise can be stripped bare by powerful cosmic forces.

Mars Orbiter Mission – Mangalyaan (2014)



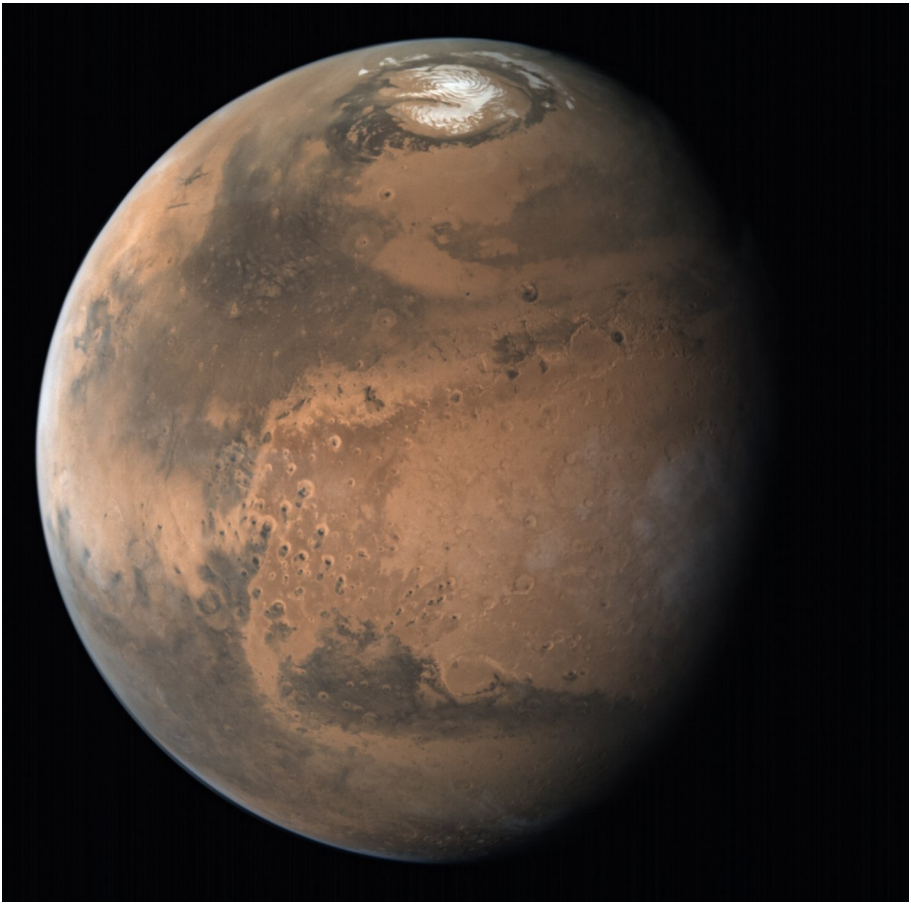
An artists rendering of Mangalyaan looking at the surface of Mars. CC by SA 2.0 by Kevin Gill https://en.wikipedia.org/wiki/File:Mars_Orbiter_Mission_Over_Mars_(15237158879).jpg

The *Mars Orbiter Mission* (MOM), affectionately known as *Mangalyaan*, marked India's powerful entry into interplanetary exploration. Launched by Indian Space Research Organisation (ISRO) in November 2013 and arriving at Mars in September 2014, MOM made India the first Asian nation, and just the fourth space agency in history, to place a spacecraft in Martian orbit. MOM was celebrated not only for technological achievement, but also for its remarkably modest price: at just US$73 million, it became the world's most cost-effective Mars mission, a feat that garnered global admiration and even resulted in the spacecraft appearing on Indian currency notes.



Instruments on board Mangalyaan. GODL by Government of India https://en.wikipedia.org/wiki/File:Mars_Orbiter_Mission_Spacecraft.jpg

The heart of the



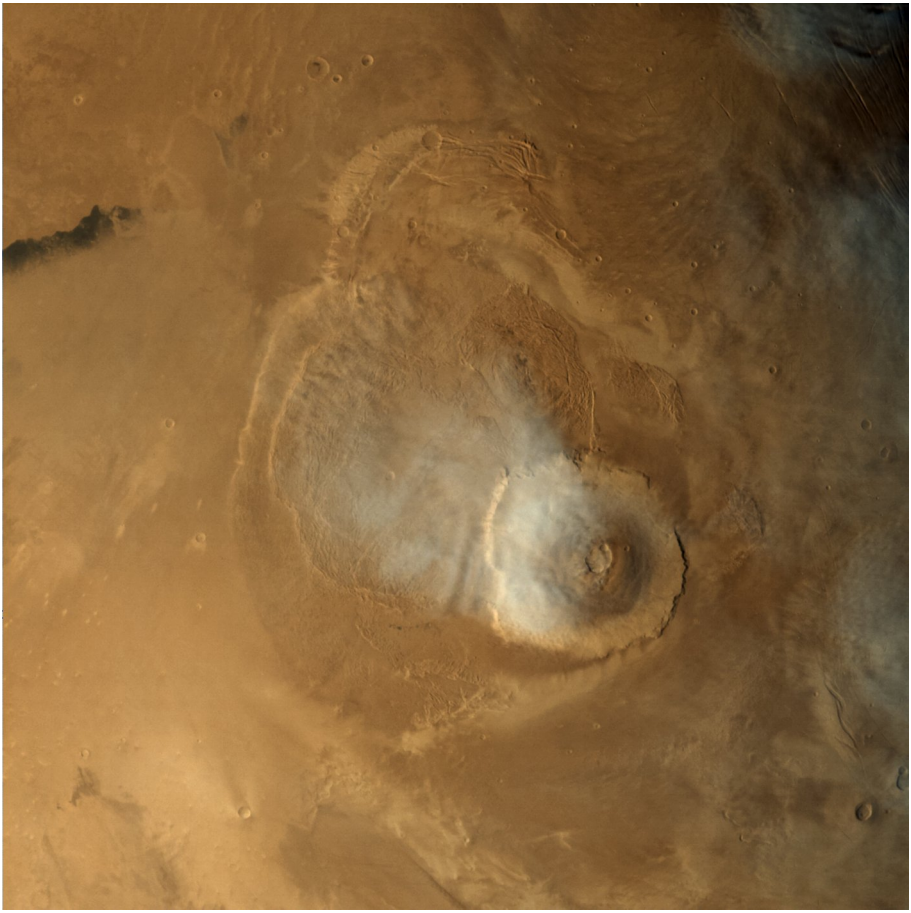
A portrait of Mars by Mangalyaan showing the ice caps at the pole. Taken on 9 December 2019. CC by SA 2.0 by Kevin Gill https://en.wikipedia.org/wiki/File:Mars_-_January_22_2016_(49196476083).jpg

mission was twofold. First and foremost, it served as a technology demonstration—a way for ISRO to test and showcase its ability to design, launch, and operate an interplanetary craft, including all the crucial aspects of navigation, communications, and autonomous operations required for a successful Mars mission. Secondly, MOM was equipped with five scientific instruments to study the Martian surface, atmosphere, and mineralogy. These included the Mars Colour Camera for snapping full-disk images and dynamic

The Mars Orbiter Mission probe lift-off from Sriharikota, India, using a Polar Satellite Launch Vehicle (PSLV) rocket C25. GODL by Government of India https://en.wikipedia.org/wiki/File:Mars_Orbitor_Mission_Launch.jpg

weather events, sensors for atmospheric composition, and analyzers for gases such as methane, hydrogen, and deuterium. The mission's Methane Sensor for Mars was designed to detect possible signs of life, but due to a later-discovered design flaw, it ended up mapping Mars's surface albedo instead—a valuable contribution in its own right.

Over eight years in orbit, MOM delivered stunning images and valuable data. Its camera captured rare global views of Mars and offered unique perspectives on Martian moons, dust storms, and atmospheric phenomena, and enabled scientists to study volatile losses and exospheric composition, including argon and carbon dioxide profiles. MOM played an



A view of Olympus Mons by Mangalyaan. Taken on 11 April 2016. CC by SA 2.0 by Kevin Gill https://en.wikipedia.org/wiki/File:Olympus_Mons_-_Mars_-_April_11_2016_(49204976516).jpg

instrumental role during conjunctions and solar events, as its transmissions helped scientists probe the Sun's corona and monitor Mars's seasons. Its orbit was tweaked to dodge the passage of comet Siding Spring in 2014, and every year the spacecraft relayed thousands of images and gigabytes of data —far beyond its original six-month design life.

Equally significant was MOM's impact as a source of pride and inspiration within India and across Asia. Its success

proved that sophisticated planetary exploration could be achieved with local expertise, home-grown technology, and considerable ingenuity. The mission inspired documentaries, films, and scientific publications, and paved the way for future Indian missions to Mars and beyond. Even after its successful mission, MOM fostered international collaboration, especially with NASA's *MAVEN* team, opening the door for joint science and future exploration partnerships.

Mangalyaan finally lost contact in April 2022 following an extended eclipse that exhausted its batteries—a gentle retirement after an unexpectedly long, fruitful career in Martian orbit. Its legacy lives on: MOM remains a testament to the "frugal engineering" and collaborative spirit that continue to define India's space ambitions.

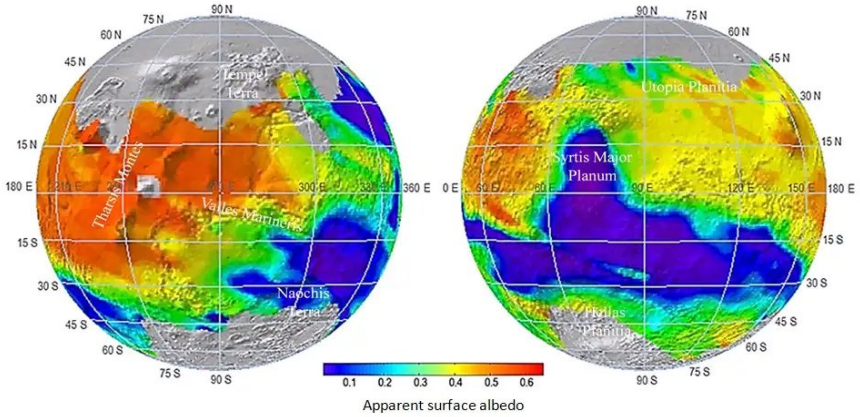


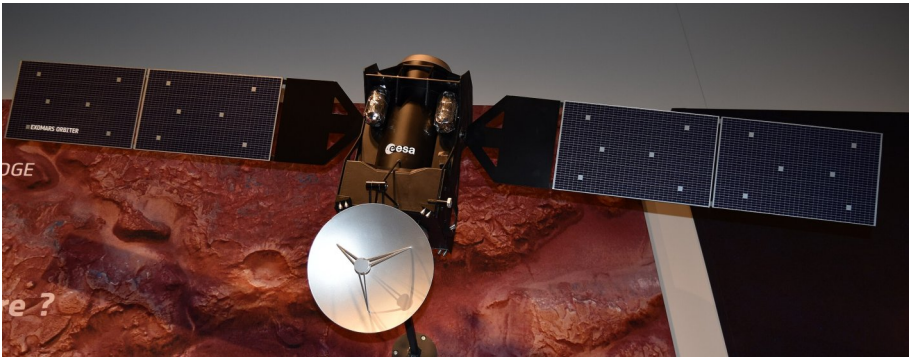
Figure: The Global MSM SWIR (1.65μm) band albedo map of Mars using Mars Orbiter Mission (MOM) data.

This mapping reveals how different regions of Mars reflect sunlight in the short-wave infrared range, highlighting surface compositions and dust coverage variations. Understanding albedo variations is crucial for studying Martian surface processes and atmospheric circulation patterns. By Indian Space Research Organisation (GODL-India), GODL-India, https://commons.wikimedia.org/w/index.php?curid=148363978

ExoMars Trace Gas Orbiter (2016)

The *ExoMars Trace Gas Orbiter* (TGO), launched in 2016 by the European Space Agency and Russia's Roscosmos, is advancing the search for life and the study of Mars's complex atmosphere. TGO's mission is to measure minuscule quantities of gases like methane, water vapour, and hydrogen chloride with unprecedented sensitivity, as the presence and variation of these gases could signal either biological processes or unusual geochemical activity beneath the planet's surface. With its powerful spectrometers, TGO surveys the planet daily, dramatically improving our knowledge of trace gases and their seasonal behaviour, while its high-resolution camera builds detailed maps of Mars's surface and landscape features.

Early findings from TGO have been transformative. Rather than confirming previous reports of methane, TGO found almost none, which puzzled scientists and suggested that methane detected by other missions might be quickly destroyed in unexpected ways. Its data on hydrogen chloride revealed a novel non-volcanic process shaping Mars's atmosphere during dust storms—an insight that changed how



Scale model of ExoMars Trace Gas Orbiter displayed during Paris Air Show 2015. By Pline CC by SA 4.0 https://en.wikipedia.org/wiki/File:Maquette_Exomars_Orbiter_Salon_du_Bourget_2015_DSC_0045.jpg

Stunning view of Mars's south polar ice cap captured by the ExoMars Trace Gas Orbiter. The image reveals layered icy deposits and red sandy streaks near the edge of the South Polar Layered Deposits.

scientists model Martian surface-atmosphere interactions. TGO has directly observed the loss of water vapour during stormy periods, tracked the daily cycles of ozone, and mapped buried water ice—treasures for future explorers. Its colour and stereo imaging system (CaSSIS) has produced remarkable images of dust devils, atmospheric layers, and possible ancient brine deposits, revealing Mars's dynamic climate and evolving landscape.

Besides its scientific output, TGO acts as a vital relay for Mars surface missions, connecting Mars rovers with controllers on Earth. Its legacy will likely grow when it supports the Rosalind Franklin rover in the coming years. As TGO continues to operate, its global datasets and discoveries are helping unravel the mysteries of Mars's atmosphere and its prospects for biological or geological activity—a key step in preparing for future human and robotic exploration.

ESA/Roscosmos/CaSSIS, CC BY-SA 3.0 IGO
http://www.esa.int/spaceinimages/Images/2018/06/Layered_deposits_at_the_south_pole_of_Mars

Insight (2018)

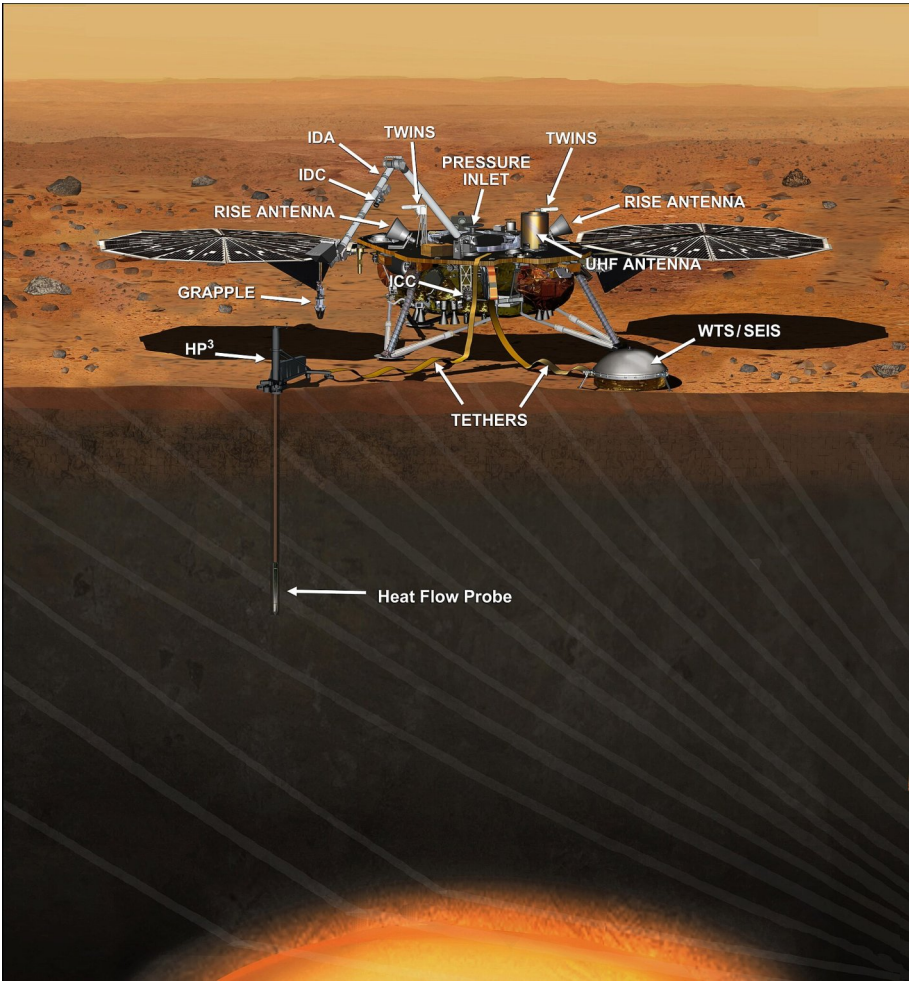
NASA's *InSight* lander, which touched down on Mars in November 2018, was the first mission specifically designed to probe the Red Planet's deep interior using sophisticated geophysical instruments. Its main science goals were to measure Marsquakes using the SEIS seismometer, monitor heat flow with the HP³ probe, and use radio science to detect minute wobbles in Mars's rotation—together painting a detailed picture of Mars's crust, mantle, and core. *InSight's* seismometer detected more than 1,300 marsquakes, including seismic waves from meteoroid impacts and deep tectonic activity, giving scientists the first detailed look at the structure and size of Mars's core, which was revealed to be a large, fully liquid region rich in sulfur and oxygen.

The seismic data also unveiled a surprise: the Martian crust is thinner and has more internal layering than expected, and in August 2024, analysis of *InSight's* quakes suggested the presence of significant volumes of liquid water deep in the Martian crust—perhaps even more than the amount lost by Mars's ancient oceans. *InSight's* unique meteorological suite continuously monitored weather, dust, and magnetic

InSight lander being made ready inside a clean room at Lockheed Martin Space Systems, Denver. This configuration is how the spacecraft will look on the surface of Mars. Public Domain, courtesy NASA/JPL-Caltech https://photojournal.jpl.nasa.gov/jpeg/PIA19664.jpg

anomalies, and its team even developed novel ways to preserve power as dust blanketed its solar panels—like cleverly using Mars dirt to clean them. Despite technical hurdles and the HP^3 "mole" probe's trouble burrowing into unexpectedly tricky soil, *InSight* kept operating until December 2022, providing a continuous record of Mars's seismic and atmospheric "heartbeat" for more than four years.

InSight's legacy is massive: it confirmed that Mars remains geologically active, mapped the Red Planet's interior with seismic waves for the first time, revealed extensive crustal layering, magnetic field surprises, and possibly deep reservoirs of water, and explained why Earth and Mars evolved so differently—shedding light on planetary formation and the ongoing quest to understand habitability in the solar system.

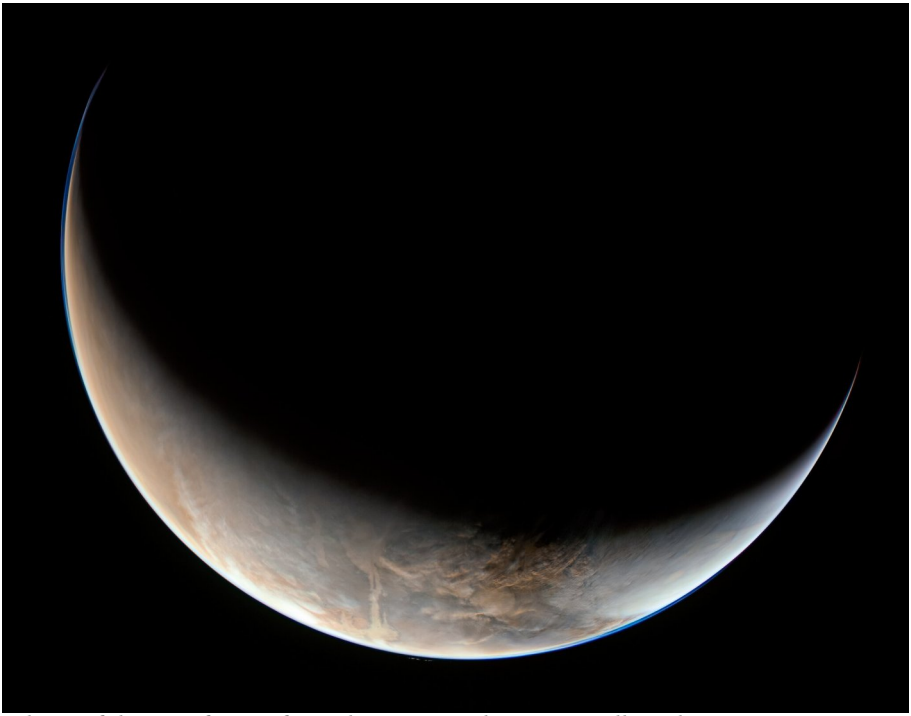


InSight lander and its instruments in depoyment. Public Domain, courtesy NASA/JPL-Caltech https://photojournal.jpl.nasa.gov/catalog/PIA17358

In 2021, three spacecraft arrived at Mars almost simultaneously: the United Arab Emirates' *Hope*, China's *Tianwen-1* and NASA's *Perseverance* rover and *Ingenuity* helicopter.

Hope (2021)

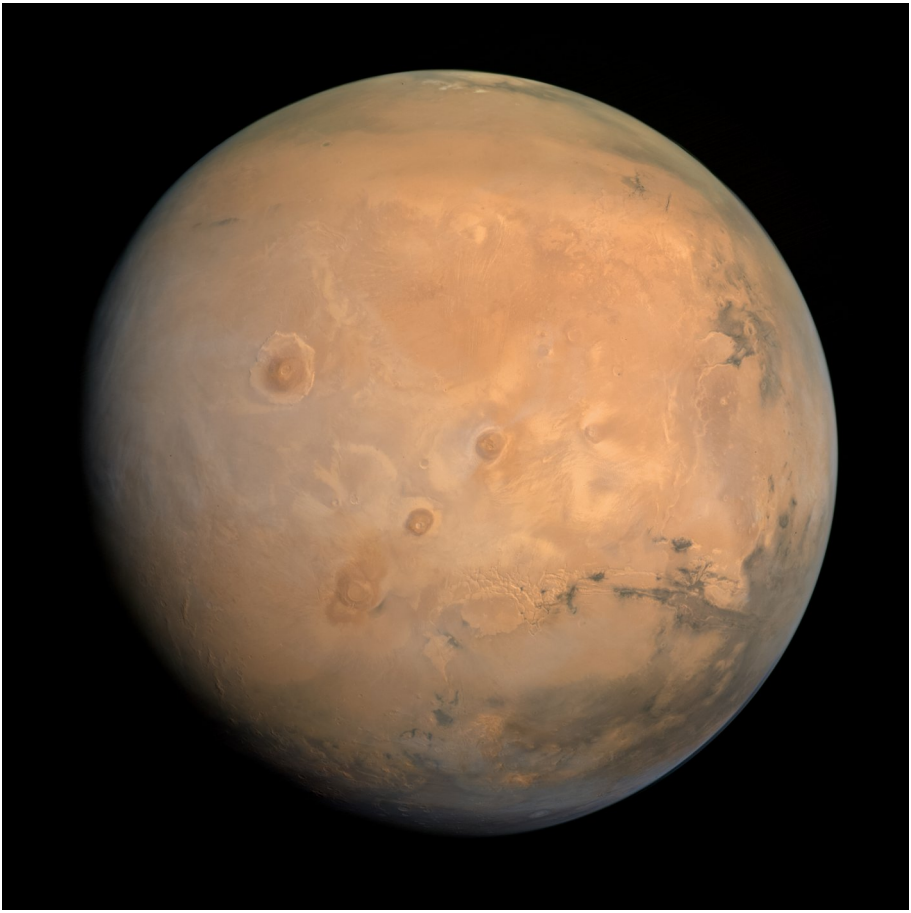
The *Emirates Mars Mission*, also known as the *Hope*, marked the United Arab Emirates' historic entry into deep space exploration as the first Arab nation and only the fifth country ever to reach Mars. Launched in July 2020 and arriving in Mars orbit in February 2021, *Hope* was built through international collaboration by Emirati engineers and partners in the US, with the mission led by UAE's Mohammed bin Rashid Space Centre. Its primary science objective is to study daily and seasonal weather cycles on Mars, monitor dust storms, and investigate how and why Mars is losing its atmospheric



A beautiful view of Mars from the Hope probe. Kevin Gill CC by SA 2.0 https://www.flickr.com/photos/kevinmgill/51588501982/in/album-72157720020618622

hydrogen and oxygen. Featuring three instruments—a digital camera, an infrared spectrometer, and an ultraviolet spectrometer—the orbiter delivers continuous global observations of Mars's atmosphere, making it the planet's first true weather satellite.

Hope's high-altitude orbit allows it to capture data on atmospheric layers, climate variations, and weather events

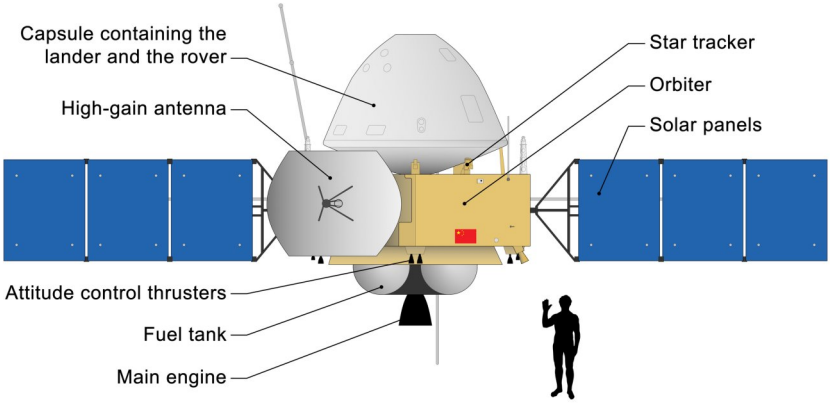


A view of Mars from the Hope probe. Kevin Gill CC by SA 2.0 https://www.flickr.com/photos/kevinmgill/51831155718/in/album-72157720020618622

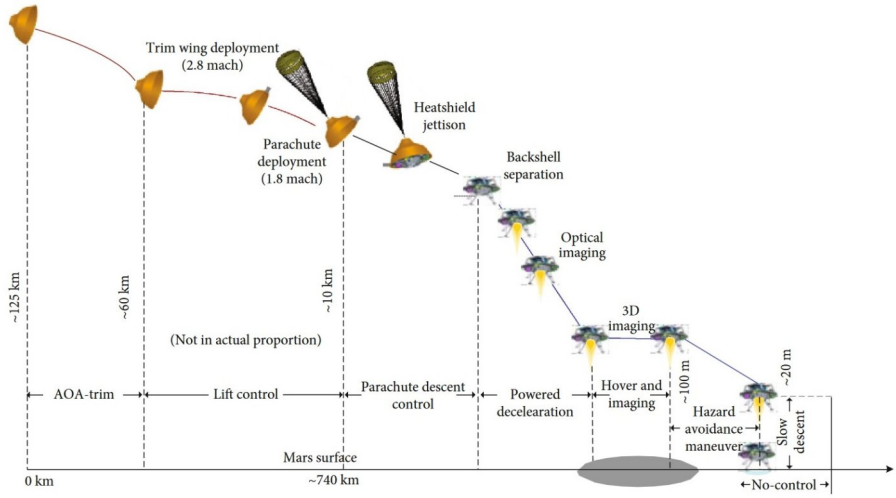
across the whole planet, filling a crucial gap left by previous Mars missions. Its findings are helping scientists understand Martian climate evolution, including the links between atmospheric escape and Mars's capacity to support liquid water in its past. The UAE has made all of the mission's data freely available to researchers worldwide, and the mission has become a symbol of optimism, technological achievement, and scientific ambition for the region—a major step towards building a knowledge-based economy and inspiring future generations in the Arab world.

Tianwen-1 (2021)

Tianwen-1, launched by China in July 2020, is one of the world's most ambitious Mars missions, uniquely combining an orbiter, lander, and rover all in a single launch and operational sequence. The spacecraft successfully entered Martian orbit in February 2021 and, just three months later, deployed its lander and the *Zhurong* rover onto the vast plains of *Utopia Planitia*. This made China only the second country, after the United

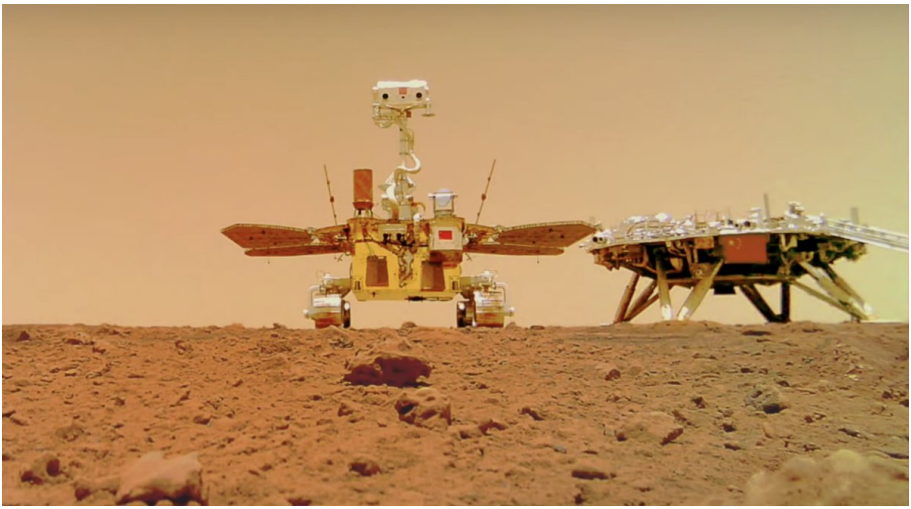


A captioned schematic of the Chinese Martian probe Tianwen-1. Scientific instruments and solar panels are deployed, the capsule is still attached to the orbiter. A human figure of 1.8 meters gives the scale. Credits Kaynouky CC by SA 4.0 https://en.wikipedia.org/wiki/File:Tianwen-1_schematic.png

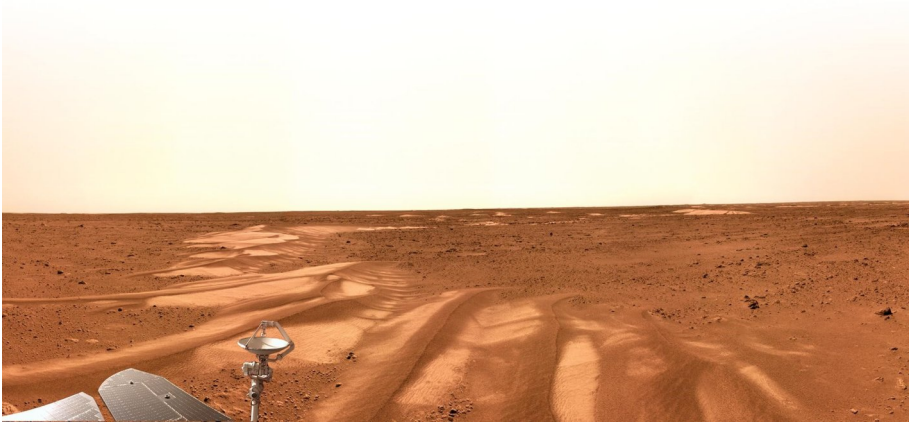


and detectors for mineralogy, weather, and magnetic field studies, allowing diverse studies of Martian geology and climate.

The *Zhurong* rover's data has yielded some of the most intriguing evidence yet that ancient Mars may have held vast



Zhurong rover group selfie with the Tianwen-1 lander, taken by the deployable Tianwen-1 Remote Camera. 30 August 2021. Credits Sleath56 CC BY 3.0 https://en.wikipedia.org/wiki/File:Zhurong-with-lander-selfie.png

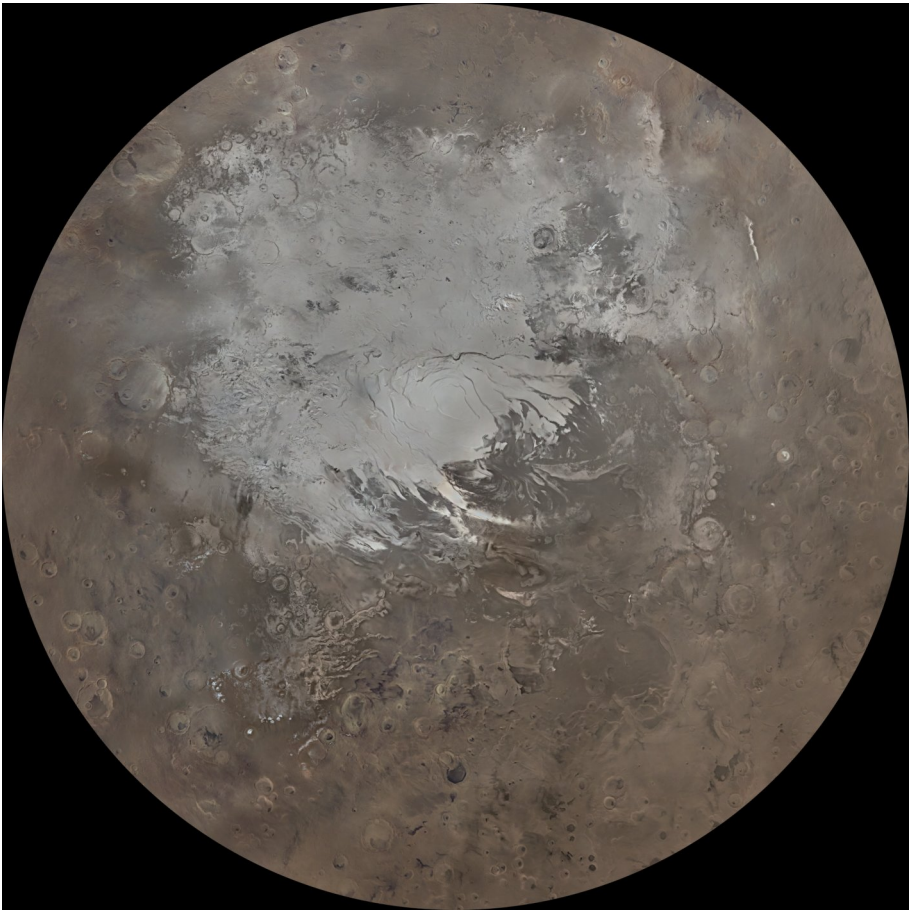


Mars surface by Zhurong rover. Credits Shujianyang CC BY SA 4.0
https://en.wikipedia.org/wiki/File:Mars_surface_by_Zhurong_rover.jpg

oceans. The rover's radar detected subsurface layers resembling terrestrial shoreline features, while its cameras and spectrometers found hydrated minerals, rocks cemented by ancient groundwater, and possible mud volcanoes—all signs of water activity in *Utopia Planitia's* deep past. These features hint at an ancient coastline and support the long-debated hypothesis that Mars's northern lowlands once hosted a massive ocean, making this region a valuable location in the search for evidence of past life. *Zhurong's* overall drive extended more than 1.9 kilometers, far exceeding its designed mission life, and helped to redefine our timeline for Martian habitability by suggesting water may have been present more recently than previously thought.

Tianwen-1's achievements extend beyond scientific discovery into the realm of technical innovation: it introduced new entry, descent, and landing systems, advanced communications, thermal management, and international collaboration, earning prestigious accolades such as the World Space Award. On top

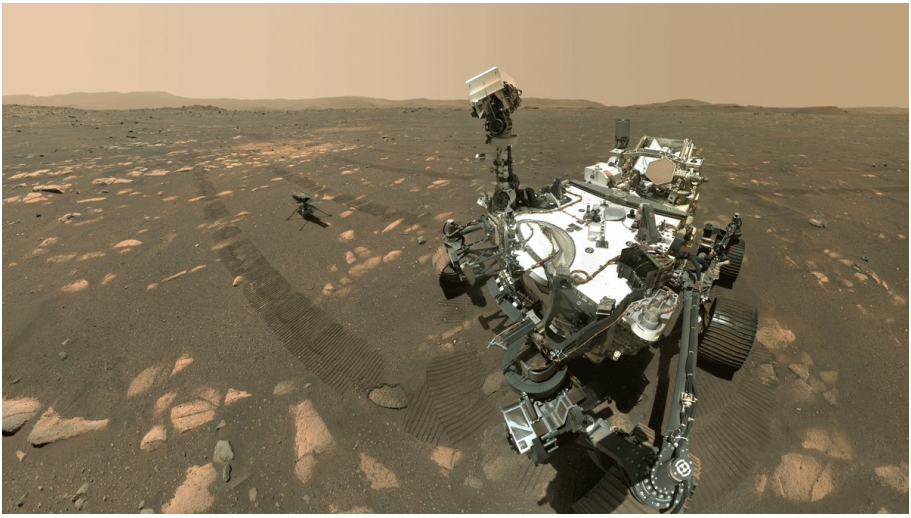
of its independent successes, the mission has fostered global cooperation in Mars science, providing an expanded international perspective on planetary exploration and marking a new era for China as a leading player in the robotic exploration of the solar system.



A Mars view by Tianwen-1 orbiter, Credits HyBoxwood CC BY SA 4.0 https://commons.wikimedia.org/wiki/File:Tianwen-1_Mars_Global_Color_Orthomosaic_chart_(HX1_GRAS_MoRIC_DOM_076m_F01_90S000E_A).png

Mars 2020 – Perseverance and Ingenuity (2021)

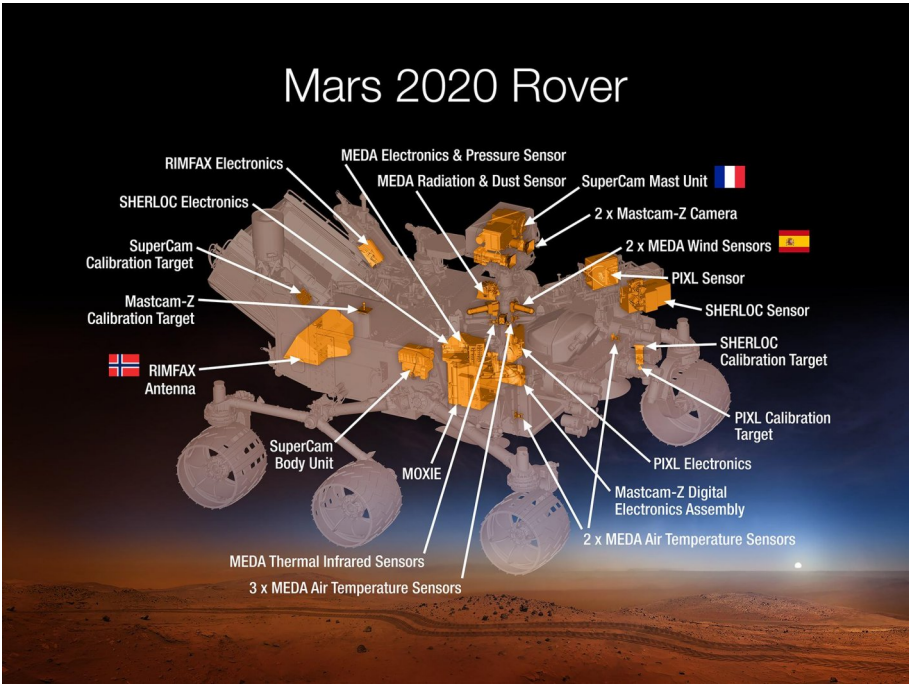
Mars 2020 is NASA's flagship mission that delivered the *Perseverance* rover and the *Ingenuity* helicopter to Jezero Crater, Mars, in February 2021—a remarkable milestone for planetary exploration. The *Perseverance* rover, the most advanced ever sent to another planet, was designed to directly search for signs of ancient microbial life, study the planet's geology and climate, and collect and cache samples of Martian



Mars 2020 selfie containing both perseverance rover and ingenuity. Public Domain Credits NASA https://mars.nasa.gov/resources/25790/perseverances-selfie-with-ingenuity/

rock and soil for eventual return to Earth. The rover's landing was a triumph of engineering, employing upgraded terrain-relative navigation to achieve a pinpoint touchdown in *Jezero*, an ancient lakebed and river delta believed to be a prime location for preserving life's possible traces.

Once on the surface, *Perseverance* quickly began surveying the landscape and drilling into both ancient volcanic and sedimentary rocks. Its first findings revealed that *Jezero Crater*



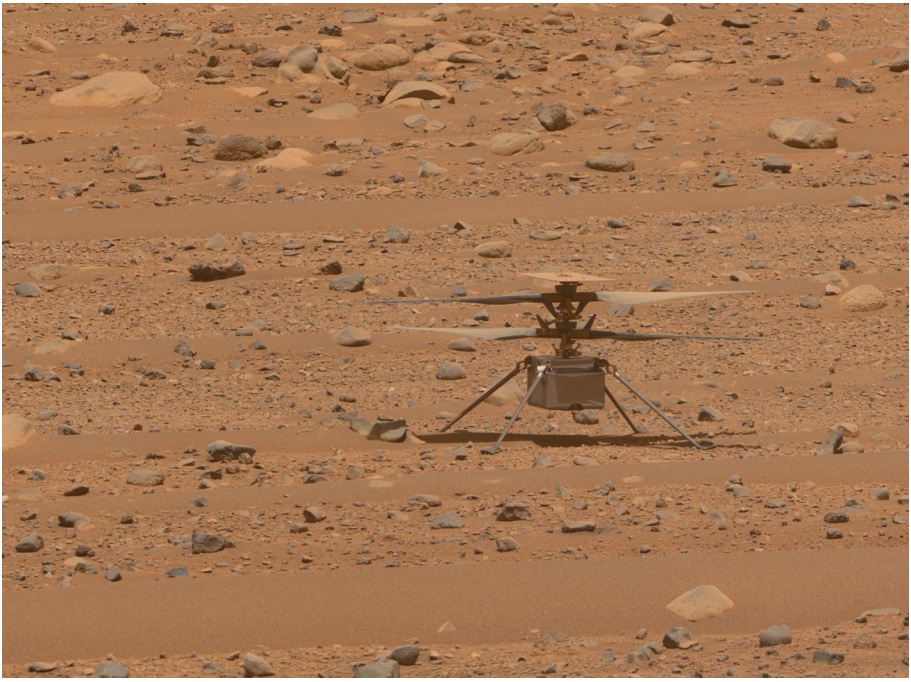
Scientific instruments onboard the Perseverance rover. Public Domain Credits NASA https://en.wikipedia.org/wiki/File:PIA19672-Mars2020Rover-ScienceInstruments-20150610.jpg

hosted a persistent lake—sedimentary deposits show that water not only flowed into the crater, but lingered, creating an environment habitable for microbes. The rover has detected organics, minerals such as clays and phosphates linked to water activity, and rocks that record long-term interaction with liquid water. Notably, *Perseverance* discovered "Wildcat Ridge," a rock formation in the crater's delta rich in organic molecules and ideal for biosignature preservation, significantly enhancing the case for past life on Mars.

Among *Perseverance's* most groundbreaking contributions is its ongoing collection and caching of dozens of rock, regolith, and atmosphere samples—meticulously sealed in tubes and left on the Martian surface for a future Mars Sample Return mission.

These samples represent humanity's best chance to directly analyze Martian material for signs of ancient biology and planetary processes with instruments far more sensitive than can be sent to Mars. In addition to geology, *Perseverance* has tested new technology for future exploration, such as the MOXIE experiment, which successfully produced oxygen from the Martian carbon dioxide atmosphere—an advance that paves the way for supporting future astronauts.

An inspiring highlight of the mission has been the *Ingenuity* helicopter, which made the first powered flights on another planet and far exceeded expectations, flying over 70 sorties across Mars. *Ingenuity's* success proved that aerial exploration



View of Ingenuity as seen by Perseverance's Mastcam-Z, taken on 18 April 2023 Public Domain By semeion.photo Credit: NASA/JPL-Caltech/ASU/Simeon Schmauß - Marsrover Perseverance Mastcam-Z Sol 768, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=144356425

Perseverance's Mastcam-Z captured this detailed view of fractured "paver rocks" on Mars's crater floor on 8 July 2021. These rocks may hold clues to the planet's ancient climate and potential signs of past microbial life. Public Domain by NASA https://en.wikipedia.org/wiki/File:PIA24746(cropped)_Jezero_Crater_Floor_Fractured_Rough.png

is viable on Mars, demonstrated the feasibility of flight in Mars's thin air, and provided scouting images to assist *Perseverance's* science operations. Unfortunately, in January 2024, during an landing procedure one of the rotor blades broke off, resulting in *Ingernuity's* permanent grounding. But this experience has allowed scientists to design more ambitious aerial crafts for future Mars projects.

The Mars 2020 mission stands not only as a giant leap in scientific inquiry but also as a crucial preparation for the next era of Mars exploration. Its results have revolutionized our understanding of the planet's volcanic and aquatic history, identified prime sites for biosignature preservation, demonstrated technologies for resource utilization and precision landing, and established the groundwork for bringing pieces of Mars to Earth—a vital step toward answering the age-old question: was Mars ever home to life?.

The last image I want to share with you is a photo of Earth from Mars taken by the *Curiosity* rover. Someday perhaps human eyes on Mars will see the same image.

This photo from NASA's Curiosity rover shows the Earth as seen from the surface of Mars, shining brighter than any star in the Martian night sky. Public Domain. https://science.nasa.gov/resource/earth-from-mars/